THE

ELECTRICAL REVIEW.

VOL. XLII. MARCH 18, 1898. No. 1,060.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

1898

Edition

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BRADFORD CORPORATION AND THE ELECTRIC TRAMWAYS.

THE *Railway World* exposes what to us seems a very questionable procedure on the part of the Bradford Corporation in respect of the electric tramways.

The particular and most glaring offence seems to be that, in calling for tenders, the Corporation has specified certain particular articles only purchaseable from particular firms; for instance, rail bonds of a special type, trucks made by a designated manufacturer, car motors of the General Electric Company's make.

Our contemporary has no fault or otherwise to find with the special articles desired and specified, but says, why ask for tenders when certain makers must be dealt with? For our own part, we do not think so much of this as does our contemporary. An individual who would build a tramway for himself would probably select what he wanted, and buy it as he pleased; but corporate bodies are supposed to have less liberty, and often this obligation to call tenders publicly results in cutting prices and bad work. But the Bradford Corporation has not stopped at this point. On the obligatory specification put forward, there were four tenders, ranging from £15,067 to £16,460—a remarkable closeness, the highest three being within a £200 range. Probably to show to the Corporation the error of their ways, one of the tendering firms—the Westinghouse Company—put in an alternative tender for £14,814, on the basis for their own apparatus in place of that specified. None of the firms had permission to put in alternative tenders, or doubtless would have been glad to do so. The one firm that did had its tender accepted. Now, this was manifestly unfair to the rest. The Corporation asked tenders for a certain thing, yet accepted something else from a firm which went outside the specification. Obviously, when the Corporation threw their preconceived notions to the winds and decided to tear up their stringent specification, it would only have been an act of common honesty to say so, and to call for open tenders. If Dick, Kerr & Co. could underbid Westinghouse by £1,200 on the close tender, the inference is they would have sent in a tender on their own lines for probably not over £14,000, and beaten the Westinghouse Company. The glories of self-government are apt to be dimmed somewhat when one has had much experience of municipal work. When there is anything more than usually technical in hand, committees seem to act without their engineer or surveyor, and, as a rule, if contractors appear before them, an *ex parte* statement may win the order.

We have not seen the specifications which were got up by the surveyor, Mr. Cox, and by the electric light engineer, Mr. Gibbings, neither of whom, in our contemporary's opinion, however good in their own special line, can be considered likely to be *au courant* in traction work. The complaint is made that the specification is full of unnecessary details, while the two Corporation engineers are to be sole adjudicators of sufficiency and quality in respect of work in which their very position in other and different lines implies they are not specialists. The specification gives conditions and tests, and, as stated above, in certain cases makes certain goods obligatory. In specifying the trucks by a given maker, the details of the trucks are elaborated. Why this unnecessary elaboration? This supererogation?

It seems to have occurred to the Bradford Corporation when they discussed the tenders, that the method of procedure which had been followed by their engineers was likely to prove costly, and that there was a chance of saving nearly £2,000 by taking a more liberal stand, and no doubt they were, so far, perfectly in the right. But they were evidently so overwhelmed with the idea of saving the amount, that they stood not upon the order of their saving, but saved at once by accepting the Westinghouse tender forthwith, never seeming to grasp the idea that other firms if free to enter in by a side door might have done still better.

It is quite possible that no member of the meeting had any idea of the basis on which the four first tenders were made. Probably they did not know just what the Westinghouse second tender was alternative to. We have no information as to what the engineers did in the matter. Their duty was to tell the Corporation the facts, and that they could not honestly accept the alternative tender. Of all this we are uninformed. We do know, however, that where there are obstinate men on a committee, the position of the surveyor or engineer is often not a happy one. Half the members of a vestry have a particular crank of their own, and are a perpetual thorn in the side of the poor engineer. If every shareholder of a railway were allowed to inflict himself upon the engineers in the way that members of corporate bodies inflict themselves on their surveyors and engineers, the working of a railway would become impossible.

The Bradford affair differs from what was known as the West Ham scandal of a year ago. At West Ham the tenders accepted amounted to about 50 per cent. in excess of the lowest tenders, had these been summed up. The explanation offered was that, in the engineer's opinion, it would be to the advantage of the public that the accepted tenders should be taken. There was a complaint from an unsuccessful firm, who were lower than the tenders accepted. They argued that as they were a company of repute, and the work had to be done to the satisfaction of the West Ham engineer, why, therefore, should thirty shillings in the pound be paid for work ostensibly in the power of the engineer to insist upon being to his liking.

The question of accepting the lowest tender is a very vexed one. Work is put out to public competition with a view to cheapness, and apparently the lowest tender of any reputable firm should be the one accepted. Even when a tender is put in at less than will pay for a good job, this is no reason to doubt the good job being secured. There may be half a dozen good reasons for tendering below cost—reasons of finance, of advertisement, and of keeping the works going. It is sometimes cheaper to work for nothing than it is to succumb to temporary slackness by discharging old hands and spoiling one's character for being a steady shop. Shops which discharge their men freely and frequently never secure more good men than they have permanent jobs for. Public tendering generally implies, then, the acceptance of the lowest tender, and this they failed to do at West Ham. At Bradford, on the other hand, they did accept the lowest tender, but it was a tender for something with which they had particularly requested not to be supplied, and most of the firms tendering had acquiesced, and tendered for what was required. One firm only tendered for entirely different goods of its own make, and, therefore, presumably cheaper, and got the order. Hence the trouble. There was a doubt at West Ham, but it was not shown that there had been any wrong doing. The Bradford affair, on the face of it, is distinctly discreditable, and though an explanation is generally thought should be forthcoming, we fail ourselves to see how the matter is to be explained, other than by boldly admitting sheer thoughtlessness, or a spirit of don't care.

Moses G. Farmer.

It is very difficult for the mere men of the crowd to contemplate with other than wonder, or perhaps curiosity, the mental attitude of a man like Moses G. Farmer, who pursued science without a thought of the solid personal benefits to be derived from it. To-day most of us, as soon as we have discovered some new fact or discerned some new bearing of an already ascertained fact, hasten to publish it, in order to obtain for ourselves priority. Indeed, in some countries, notably in France, there is an elaborate system of sealing papers, whereby a man may state in general terms something into which, perhaps, he has obtained some insight, and then when someone else comes forward at a later date, he can produce from the archives of the Academy of Paris his hidden statement, which guarantees him that much coveted priority. Vanity is doubtless at the root of this curious practice. This quality, for it is a quality, and a good one if it is properly balanced, is the last which we could possibly ascribe to Moses G. Farmer. In him the world had a clever, industrious worker, who observed, deduced, and noted down facts, which, had they been published at the time, would have covered him with honour and renown. We can quite sympathise with this modesty, but to-day can see the pity of it, for had those notebooks been given to the world, applied electricity would, without doubt, have come more rapidly into prominence in the industries of mankind than it has done. It may be said that the new science has come on quite fast enough, but useful progress in the application and acquirement of knowledge cannot proceed too rapidly. To-day our American contemporaries are recognising that Moses G. Farmer was a great inventor. In an address before the American Institute of Electrical Engineers, Dr. George F. Barker has pronounced a well merited eulogium on the man and his work. It would be a good thing for the rising generation of electrical engineers if a biography of Farmer could be placed in their hands. It would prove not only interesting and encouraging, but inspiring. In Farmer's work there was no cheap clap-trap, no striving after effects which would dazzle the multitude, no dashing about in order haply to light upon the fact of which he was in search, no rule-of-thumbism. He proceeded slowly and steadily, measuring his paces and calculating his distances, until he was able to gain the end he had in view. Nothing is so characteristic of this than a little incident which took place in 1860, when, on the celebrations in connection with that American Saints' day, July 4th, an exhibition of the electric light was arranged to take place on the Boston State House. Prof. William B. Rogers had charge of the exhibition, and a very large battery was placed in the dome, and wires were led up, and this light was shown at the same time with the fireworks on Boston Common. There was somebody else up there beside Prof. Rogers and his assistants, and that man was Mr. Farmer. They wanted to make a display; they wanted to show an electric light larger than any that had been seen up to that time. Mr. Farmer had no such idea. He wanted to do what had not been done in the world before, and what has not been done, possibly with one exception, since. He wanted to determine how much power, how much horse-power it required to produce that light, and out of the data which he obtained in those experiments in the dome of the Boston State House on that night of July 4th, 1860, was the mechanical equivalent of light, and he gave us the fact that to support the light, not the heat, but the light of one candle required the expenditure of 13·1 foot-pounds per minute. Some time after that Prof. Thomson, of Copenhagen, undertook from similar data to get a result, and the results were very closely accordant. It is sincerely to be hoped that Mr. Farmer's note books will be edited and published. Their contents are believed by those who have inspected them to consist of matter which was new science at that time. He was a great inventor, and deserves that certain discoveries which figure in those note books should be credited to him. The work of Farmer has passed unconsciously into the work of others, but had his individualism been more energetic, he would have been recognised during his life as one of the greatest leaders in the application of electricity.

SOME NOTES ON SINGLE-PHASE MOTORS.

By A. C. EBORALL.

(*Continued from page* 277.)

At first sight it might appear that it would be more economical and cheaper to put the starting resistance in series with the *stator* for the purpose of reducing the starting current. This is, however, not possible, as the output of an induction motor is practically proportional to the square of the supply pressure, and hence the reduction of this at starting would, in the case of single-phasers, prevent the motor starting at all. Hence this is never done in practice.

It may be remarked here that the fact of the output of an induction motor being very approximately proportional to the square of the impressed pressure, makes it essential that the regulation of any motor circuit should be fairly good, because should the tension on the line suddenly decrease from any cause, such as might be produced by starting up a large motor too quickly, or without its resistance, any heavily loaded motors on the circuits at the time might pull up; for a motor that would carry considerable overload at its normal tension, would barely take its full load with a reduction of 25 per cent. in the line pressure. As, however, single-phasers are only used in conjunction with lighting systems, it follows that the amount of overload such a motor will take will practically depend on the quality of the design.

The above is the only way in which the pressure on the stator affects the speed regulation of an induction motor—whatever the number of phases.

The effect of frequency on the running performance of a single-phase induction motor is not very greatly felt between 30 and 60 ~ in a given design, although it may make considerable difference to its starting powers. Theoretically it should make no difference at all, and would not do so except for the fact of the motor poles increasing directly with the frequency for a given speed. That is, in large motors, the poles become very numerous as the frequency is increased, because the speed of such motors must not be too high. The effect of increasing the poles in any given type of machine is to increase the magnetising current and also the leakage. It is this last factor that counts the most, and so in high frequency motors the power factor is not so good, and the starting rendered more difficult than in those working at the same speed on a circuit of moderate frequency.

The whole question of the design of induction motors really resolves itself into this question of leakage, which takes into account nearly all the quantities involved, such as dimensions of air-gap, induction density in it and in the stator, depth of winding in stator, and distribution and form of winding in rotor and stator. The induction motor with least leakage will always start best, have highest power factor, least slip, and hence be better all round.

Having now considered the broad principles underlying the construction and running of single-phasers, it may prove of interest to describe the different starting devices actually used by the various makers, and to briefly discuss the results attained.

(*A*) *Messrs. Brown, Boveri & Co.*—This firm was the first in the field with a commercial single-phase motor, and many hundreds have now been sold, in units ranging from $\frac{1}{10}$th to 70—80 H.P. The table given below shows the weights, efficiencies, &c., of stock sizes of their motors, arranged for running on circuits of 30 to 60 ~, and 100 to 500 volts.

5,000 volts, this being transformed down for the starting winding.

Motors up to No. 5, inclusive, have simple short-circuited bar rotors, and must start on a loose pulley. The starting current is about equal to the full load current. From No. 7 to No. 13, the rotors are all wound with three slip-rings on the shaft for the insertion of a resistance, as before described. If they start on a loose pulley, the starting current is somewhat less than the full load current, but they will all start against some load if enough current is allowed them. No. 6 can either have a plain or wound rotor, depending on the frequency. For higher frequencies than 60 ~ the wound rotors commence at either No. 4 or No. 5.

The different starting arrangements used with these motors are as follows :—

For motors up to and including $\frac{1}{2}$ H.P., the device shown in fig. 11A is used. At starting, the working and starting windings are put in series, the latter being shunted by a non-inductive resistance. The current will, therefore, lag more in the working than in the starting winding, and hence, as

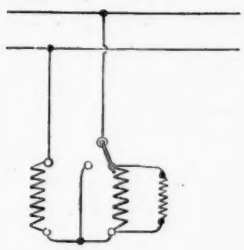


Fig. 11A.

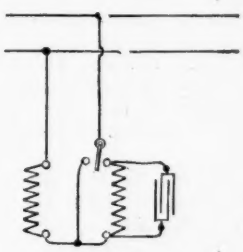


Fig. 11B.

the two windings are displaced 90° from one another, an imitation rotary field will be produced, causing the rotor to very quickly run up to speed, when the starting coils and resistance are cut out, and the working coils put direct on the line.

Fig. 11B shows the arrangements for motors above $\frac{1}{2}$ H.P., and up to 6 H.P., when a starting resistance in the rotor is not used. The arrangements are exactly the same as in the first case, only the resistance shunting the starting coils is replaced by a liquid condenser. The leading current in the starting coils acts in just the same way as in the other case, causing the rotor to very quickly run up. The liquid condensers employed are very simple. They consist of a number of thin iron plates, separated by thin fibre strips, and arranged in an enamelled iron vessel containing soda solution. The manner in which the plates are connected (*i.e.*, in series or parallel), and the density of the soda solution employed, is determined for each individual motor, the solution, &c., being adjusted in the test-room until the best effect is obtained, the whole adjustment occupying but a very few minutes. It is necessary to treat each case separately, as minute differences in the air-gap, and differences in the windings for varying voltages and frequencies, prevent the condenser arrangements being exactly standardised.

These liquid condensers are practically indestructable, and never get out of order if properly made and used. A little water must be added occasionally to make up for evaporation. To give an approximate idea of the size of one of these condensers, it may be stated that the overall dimensions of one for a 4-H.P. motor would be about 9½ inches long by 6¼ inches wide by 8½ inches deep.

Fig. 12A gives the starting arrangements used for all

Table I.

Reference number.	1	2	3	4	5	6	7	8	9	10	11	12	13
Horse-power	0·1	0·3	1·0	2	3·5	6	9	13	20	35	45	65	90
Approximate weight (in pounds)...	40	60	140	240	400	620	1,000	1,400	1,700	3,100	4,000	5,200	6,800
Full load efficiency (per cent.) ...	50	60	65	70	73	76	80	84	88	90	90	90	91
Apparent watts per H.P.	2,260	1,750	1,570	1,420	1,330	1,240	1,150	1,080	1,020	1,000	1,000	1,000	990

The weights given include starting apparatus and rotor resistance when this is used. The larger motors (from about No. 10 upwards) can be arranged for any tension up to

Brown motors where a rotor resistance is employed. The resistance having its maximum value, the line current is switched directly on the working winding, the starting

winding, in series with a liquid condenser, being in parallel with it. The artificial rotating field produced causes the rotor to run up. As it runs up the rotor resistance is gradually reduced, the condenser and starting coils being cut out at about two-thirds of the normal speed.

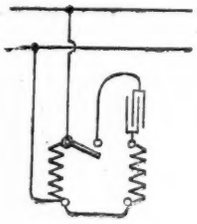


Fig. 12A.

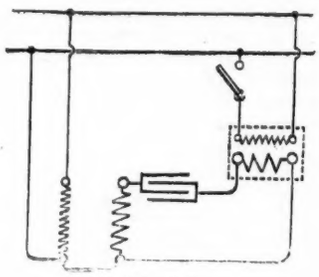


Fig. 12B.

The last arrangement described is somewhat modified in the case of large high-tension motors. Thus fig 12B shows the starting arrangements used with some 70 H.P. Brown motors at Frankfort. They are worked direct from the primary network at 2,800 volts. The working winding is straight on the mains as in the last case, but the starting winding and condenser are connected to the mains through a small transformer, which reduces the pressure to a lower value more suited to the condenser. When at about two-thirds of the normal speed, the transformer, &c., would be switched off.

Fig. 13 gives a view of a Brown starting resistance and condenser. The resistance is a star-connected non-inductive nickeline wire resistance, it being enclosed in a cast-iron box filled with oil. This arrangement allows the use of a high current density in the wires, owing to the excellent cooling afforded by the oil. The contacts, giving five degrees of variation up to the short circuit position, are arranged on the marble cover, and the whole forms a very compact and efficient arrangement. The external appearance of the condenser is well shown in the photograph.

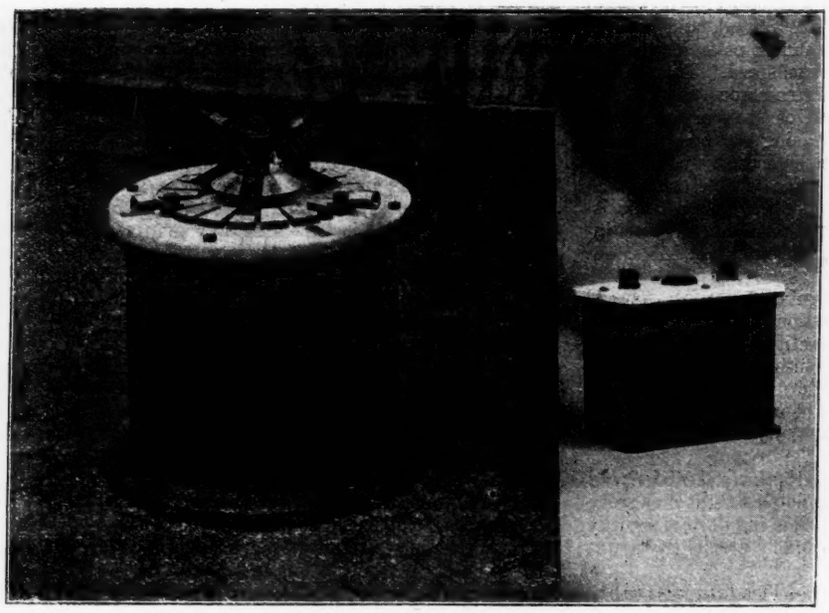


Fig. 13.

(*To be continued.*)

Electric Police Lanterns.—It is stated that the authorities at Scotland Yard are now engaged in subjecting a police electric lamp to practical tests, to ascertain if it will stand the necessary wear and tear of the service.

SERIOUS BREAKDOWNS FROM PRIMING.

YARMOUTH was reported last week to have been in a state of darkness, the whole of the electric lights being suddenly extinguished. To make a long story short, we learn that three Willans engines and one of another make were suddenly wrecked by what is generally held to have been a sudden and excessive priming of one or more boilers, but whether caused by overfeeding or otherwise we suppose may never be known. An exceedingly funny report appears in a Norwich paper—evidently of non-technical origin. As usual with such, things seem to have been *hurled* about, and *ponderous* masses of iron so hurled have done a lot of *rebounding*. In fact, the description of hissing steam and roaring water seems to point to a sort of Niagara let loose in—the paper calls it Pandemonium, which seems about seven letters too long. Unless the water be very dirty, boilers which do not prime as a rule, do not suddenly give large volumes of priming, but if the water level has been allowed to get too high, the rush of steam over its surface might set it in motion, and finally gather it up in a vortex and produce the damage recorded. The idea of priming being the cause seems to be borne out by the simultaneous damage of four engines at once. The boilers are, we understand, of the water tube variety, and we believe there were no water separators on the steam pipe. A water separator is a fairly efficient instrument for producing dry steam, *i.e.*, steam free from a serious amount of water in a mass. The steam may remain misty but this will not damage engines. The main steam pipe from boilers to engine ought to bend at an absolutely square bend, the pipe from the boiler being continued a few feet past the branch to the engines, and terminating in a fair sized vessel drained by a good trap.

The engine branch may best be taken off square from the top of the steam main. Another suitable water-trap is to carry the steam pipe into the side of a fairly capacious vessel, the pipe turning down inside and discharging its steam and water towards the bottom of this vessel, which should be of some depth. The outlet should be from the top, and the cross-section of the vessel should be quite four times that of the steam pipe, so that the upflow of steam may be slow. A vessel like this in the length of the steam pipe would deal with sudden masses of priming, but it is obvious that it should be of some considerable depth and size so as to deal with the largest probable bulk of water. Of course, the sudden priming of a few gallons or even quarts might wreck several engines. A thimble full in a cylinder beyond what will fill the clearance space will wreck an engine. Even where relief valves are fitted these are never more than sufficient to discharge just the small amount of ordinary wetness which may accumulate in the cylinder, and is discharged when the piston is moving at its slowest just at or near the dead point. A large mass of water filling a greater length of the cylinder cannot be dealt with by relief valves, because the piston motion is so much more rapid at the time the relief valves are called on to act and the water cannot escape fast enough to prevent a breakage. Some years ago when relief valves of the short-weighted lever type were tried they acted, but they only acted once. The call to act was so sudden that the valves lifted and let out the water, but the weights did not lift. They remained stationary, or nearly so, and the levers bent under the sudden pressure of the valves.

Experience seems to have shown that water tends to find and travel along the lower side of a pipe, and water being heavy and devoid of any potentiality of movement in itself,

it follows that law of motion which tells us that a body in motion tends to keep in motion in a straight line if unacted upon by any external force. Steam can of itself turn a sudden corner. Hence in a square bend pipe the water rushes forward past the bend and may be caught.

In a pair of engines supplied from one steam pipe it is common knowledge that the first engine has fairly dry steam, while the second only a few feet further gets all the water. This is but the action of the above law, and the fact that steam pipes are generally fixed so as to provide that the water shall travel all the way with the steam, is a proof of the little grasp of laws which the system of teaching mechanics gives to our engineering students. In the fixing of exhaust injectors better working is always secured when the pipe to the injector springs squarely from the exhaust pipe, for thereby it snatches dry steam, and the water and also the oily particles rush onward.

The danger of carrying the water at too high a level in a boiler is not perhaps so dangerous in boilers of large water surface area as in the small steam drums of water tube boilers in which probably it is easier to set the water in motion. Some safeguard is desirable against too high a water level, but this alone will not protect engines. The only safeguard is a sufficient separator, and as dry steam is always so much more economical than wet steam, the expense of a separator will very soon be returned.

ON SOME RECENT INVESTIGATIONS IN CONNECTION WITH THE ELECTRO-DEPOSITION OF METALS.*

By J. C. GRAHAM.

(*Continued from page* 320.)

Now, going back to the Diagram D, the first vertical column on the left hand under the fig. 1 shows the behaviour of an anode the same size as the cathode, when connected to one cell, two cells, three cells, &c., up to six cells. The second vertical column under the fig. 2 shows the behaviour of an anode double the size of the cathode, and so on.

The observations for each square were during 10 minutes, and were made every 15 seconds.

It will be noted that although the amperes which passed just at the moment when the current was switched on were pretty nearly in proportion to the electromotive force, the amperes which were passing after an interval of 10 minutes did not follow this proportion even approximately:—For example, the terminal amperes with one cell were about $1\frac{1}{4}$, and with six cells they were only about $2\frac{1}{8}$, with an anode the same size as the cathode.

It will also be seen from Diagram D that as the anodes became larger, the difference between the initial and the terminal amperes decreased, but with an anode eight times the size of the cathode the terminal amperes when working with six cells were only 80 per cent. of the initial amperes; that is to say, there was a drop of 20 per cent.

Although no gases appeared to be formed on either the anode or the cathode, it seemed possible that they were formed on the anode, but escaped observation, and that the fall in the current density might be due to this cause.

In order to test this hypothesis, lead anodes were substituted for copper ones, because it could be predicted with certainty that gas would be formed on them, and if the shape of the curves was due in any way to the formation of gas, it might be expected that the curves with lead anodes would exhibit all the peculiarities of the curves with copper anodes, but in a more marked degree. This, however, turned out not to be the case. This is shown in Diagram D_1, where the red line shows the current passing through a lead anode of the same size and shape as the copper anode which produced the black line. Clouds of gas came off the anode during this experiment. The broken lines in the columns 1 and 3 of Diagram D show the currents produced when lead anodes were substituted for copper ones at various voltages.

* Communicated to the Royal Society.

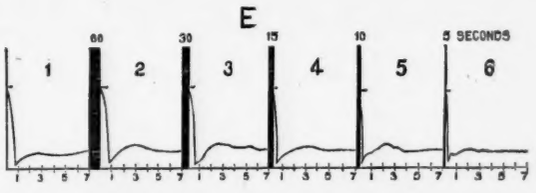
On looking at the broken lines where one cell was used, it will be seen that the current passing through the lead anode is less than that which passed through the copper one, the reason no doubt being that the lead produced a back electromotive force which was a large proportion of the electromotive force of one cell; but if the current passing through the lead anode when six cells were used be contrasted with that which passed through the copper anode, it will be noticed that the lead anode, notwithstanding the back electromotive force, allowed nearly three times the number of amperes to pass. This is clearly shown by Diagram D_1. And in all cases the current passing through the lead anode remains tolerably constant, and never shows the tendency to decrease which is apparent when copper anodes are used.

The drop in the current in the latter case can hardly be accounted for by polarisation, as this ambiguous phrase is ordinarily understood, for the drop is almost absent where the polarisation is the most perfect. In some experiments, which will be referred to later on, this drop disappeared where the anode was well washed by a rapid flow of the electrolyte. This rather points to the conclusion that it is due to the formation of sulphate of copper, which may take some time to dissolve.

It should be stated here that the curves shown on Diagram D_1, merely show the curves obtained in these particular experiments. These curves would probably change in form with any change in the shape of the anode, or in the distance of the anode from the cathode, the density of the solution, &c., but would maintain their characteristic peculiarities, viz., a sudden drop, followed by a rapid partial recovery.

The copper anodes show a tendency to blacken when small currents are passing, and become perfectly bright when dense currents are passed through them. Repeated experiments, however, showed that this had very little, if any, effect on the shape of the curves. Dense currents were passed through anodes which had become quite black, and small currents through anodes which had been made bright, and the curves were, practically speaking, the same, whatever the condition of the anode was at the commencement of the experiment.

The copper anodes also exhibited a capacity for rapid recovery. If the current, after it had come to its ultimate density, was switched off for a short interval, and then switched on again, the initial amperes were found to be almost the same as they were at first. This is shown in Diagram E. The experiments are numbered successively



1, 2, 3, &c. The anode area was double that of the cathode, and in all of them six cells were used. The current passing in each experiment is shown by the black curved lines. The operation was as follows:—The current was switched on and allowed to flow for seven minutes, giving curve No. 1. It was then switched off for 60 seconds, and again switched on and allowed to flow for seven minutes, giving curve No. 2. It was then switched off but for 30 seconds and allowed to flow for seven minutes. It was then switched off for 15 seconds, and so on.

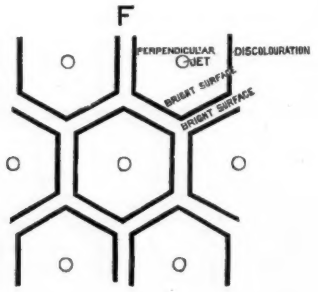
The initial amperes are nearly the same throughout, but the fall is more rapid as the time given for recovery is made smaller.

As the conditions necessary for getting fairly accurate results appeared to have been ascertained, a number of experiments were made at various current densities. It was found that with the apparatus shown in Diagram C copper could be thrown down at as high a current density as 2,000 amperes to the square metre, over a period of one hour, at the end of which time little round nodules had begun to appear.

The copper which is deposited at these high current densities does not appear to be either much harder or less ductile than that deposited at 150 to 300 amperes to the square metre. If it is deposited in the sheet form it can be doubled

and opened without cracking, and if deposited in the wire form it can be drawn to any practicable fineness.

These experiments were made with a saturated solution of sulphate of copper; further experiments showed that the rate at which copper can be deposited appears to be approximately proportionate to the amount in solution. With double the



amount in solution the copper can be thrown down at double the rate; but accurate determinations are not possible, as there is no definite means of comparing the deposits.

Experiments were also made with a number of small jets substituted for one large one. Such jets, however, produce discoloration on the cathode along the lines where the currents meet, as shown in Diagram F, the dark lines showing the discoloured places.

(*To be continued.*)

THE "OPEN ARC" GROOVED CARBON.

The "open arc" carbon is the name which has been given to a new and interesting form of arc carbon recently brought out, and for which a number of valuable qualities are claimed, not met with in the ordinary form of solid carbons.

The distinguishing feature of this new type of carbon is a longitudinal groove running from one end to the other parallel with the length of the carbon, as shown in the accompanying figures, which we reproduce from the New York *Electrical Engineer*.

By the use of this carbon it is claimed, first, that the vortex action of the current is checked by the groove, and the crater of the carbon is held stationary at the apex of the pencil; and what is still more important, is that the size of

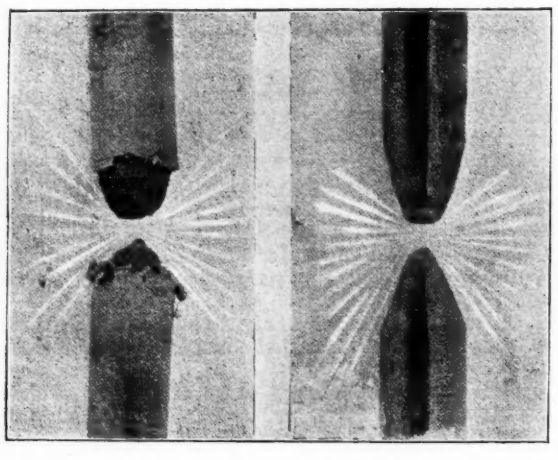


Fig. 1. Fig. 2.

the white light crater is nearly double that of any other carbon. This is explained by the inventor thus: With the solid or cored carbon that part of the white light crater is only visible which is on the apex of the carbon; with the grooved carbon, however, the crater appears as well on the sides of the segment cut out of the carbon as on the end, almost doubling its light rays.

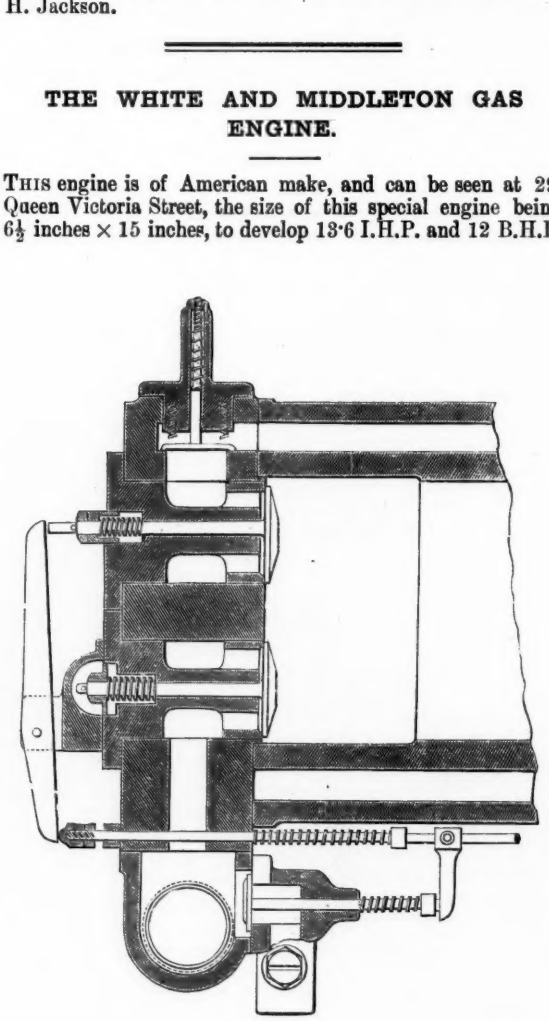
It is also claimed that with a solid or cored carbon, the maximum heat point is the centre of the carbon, hence, the centre of both carbons disintegrates too rapidly, leaving walls on either side which, a large portion of the time, obscure the crater, and build up on the lower carbon to a point that shuts off the rays from travelling downward. With the "open arc" carbon, it is claimed that the grooves cut the material from the centre, leaving nothing there, and throwing the maximum heat point to the sides of the pencil, thus giving the lower stick a cone-like form, and allowing all the rays to travel downward.

The accompanying figure illustrates this action, and was made from photographs taken from two sets of carbons burning side by side in high tension lamps, both sets of carbon being coppered. Another point made, is that a $\frac{5}{8}$-inch carbon, solid or cored, while desirable for a long run, is a poor light developer; but with the "open arc" carbon, this result, for the reasons before given, does not obtain.

This new form of carbon is said to increase the illuminating power of the arc from 30 to 40 per cent., without any increase in current consumption, and if this be so it unquestionably has claims to recognition. We may add that the new product is being introduced by the Open Arc Carbon Company, of 108, Fulton Street, New York, and that a number of prominent electrical men are interested in the company, among them Mr. Charles A. Lieb and Mr. Caleb H. Jackson.

THE WHITE AND MIDDLETON GAS ENGINE.

This engine is of American make, and can be seen at 29, Queen Victoria Street, the size of this special engine being $6\frac{1}{2}$ inches × 15 inches, to develop 13·6 I.H.P. and 12 B.H.P.



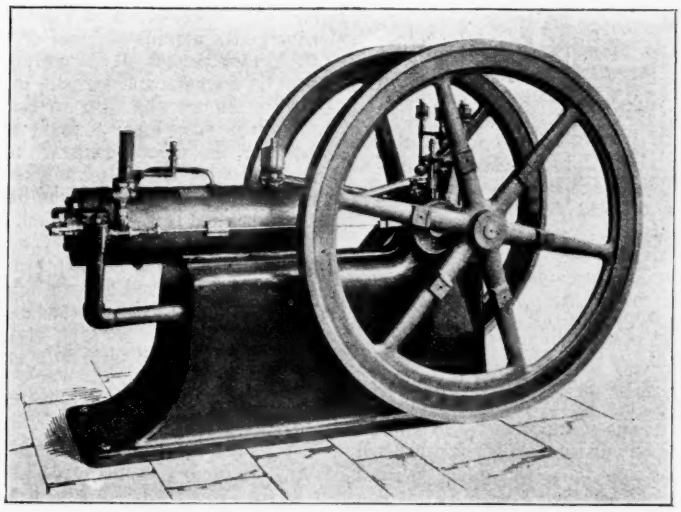
Like most engines of to-day, it is worked on the Otto cycle, but it is modified from most engines by the possession of an exhaust port at the forward end of the cylinder, which is uncovered by the piston on its extreme outward stroke,

and thereby the ordinary exhaust valve is made much smaller and exposed to much less wear, only about a tenth of the exhaust escaping this way. The ordinary trunk piston is used, but has no rings. Ignition is by incandescent tube.

The valve gear is driven by small spur gears from the crank shaft. It consists of a revolving cam which drives a push rod through the medium of a friction wheel swung into contact with the cams by the governor. When the wheel comes against the cams the gas valve is opened.

When seen by us running light, the engine only required one explosion to run it on an average fully 15 revolutions. Indeed, the running was remarkably good and easy, and the engine is well made and neat in design.

Tests reported in the maker's catalogue show a consumption of only 16 feet of New York gas per brake horse-power-hour. The floor space occupied by the 12-H.P. engine is 7 feet × 2 feet 9 inches, and the fly-wheels, of which there are two, are 4 feet 8½ inches diameter. The belt pulleys are arranged to be screwed against the side of the fly-wheels, thus avoiding extra length of shaft, and avoiding stress on the fly-wheel keys to some extent.



White & Middleton Gas Engine.

The engine is readily convertible into a gasolene engine by removing the gas inlet, and substituting a small oil pump with electrical ignition in place of the ignition tube. The exceedingly neat and simple external appearance of the engine, and the absence of gearing and projections generally, give to it a very pleasing appearance. It gives a good indicator diagram, and is altogether a very good and well made machine. The forward exhaust port is, we think, an item that might be adopted with advantage in other engines.

KINGSLAND'S SURFACE CONTACT SYSTEM OF ELECTRIC TRACTION.

There appears to be a feeling at the present time among tramway experts, that the "surface contact" system is likely, under some circumstances, to come into limited use. It is noticeable that in America, which is greatly ahead of this country in tramway work, there is a disposition to adopt in some places a form of conduit system.

In many towns in this country where the "overhead" has been adopted it has been so because it was felt to be, so far, the only system which had proved an undoubted commercial success; but in most cases a reliable underground system, had such been available, and inexpensive in first cost, would have been welcomed.

The "open conduit" or "slot" system has not proved itself to be a serious competitor to the "overhead"; its disadvantages are many and its expense great. There remains the "closed conduit," or "surface contact," system; in which the whole of the conductors and other electrical apparatus is put underground, and the current is collected by the car from a number of surface contacts or studs placed at intervals along the track, their distance from each other being approximately the length of a car. These studs must be cut in and cut out of circuit as the car advances from one to another, and there must be no chance of any one stud being left "alive" after the car has passed it.

What may be called the intrinsic disabilities of the "overhead" and the "slot" systems respectively, do not pertain to the "surface contact" system; and there is in reality only one qualification to be demanded from it, and that is its reliability. The question is, can the automatic switches which are required to cut in and cut out the various sections or surface studs be relied upon to fulfil their functions with a minimum chance of failure?

The various patented devices for these automatic switches are very numerous, but the invention of Mr. Wm. Kingsland is claimed to possess some novel and interesting features which have not been hit upon by previous inventors, and which are stated to give the system some decided advantages which will readily be appreciated from the following description of the apparatus and method of working.

Fig. 1 is a diagram showing the main principle which is followed in the arrangement of the conductors and switches. M M is the main conductor, R R the rails, and S R^1, S R^2, S R^3, S R^4 are the sectional rails, or surface contacts, from which the current is collected by the car, and which may be simply studs instead of rails, as shown in the diagram. S^1, S^2, S^3, are three switches, each of which consists simply of a lever, *l*, which operates a sliding contact bar, the function of the bar being to connect the two contact springs, *a* and *b*, or the two similar contacts, *c* and *d*. It will be seen that when the levers are all in one direction, connecting, let us say, the contacts, *a* and *b*, of each switch, there is no electrical connection between the main, M, and any one of the surface contacts, S R^1, S R^2, &c. But if the lever, *l*, be moved to the right so as to separate *a b* and join *c d*, then there will be an electrical connection between the main and the surface stud, S R^2. Now let us suppose a car to be on

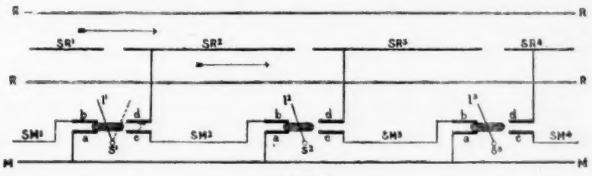


Fig. 1.

S R^2 and moving towards S R^3. When it reaches the lever, l^2, it will carry it over to the right, thereby opening *a b* and closing *c d*. The opening of *a b* disconnects the surface stud, S R^2, and the closing of *c d* connects the following one, S R^3. An advantage is said to be gained by this arrangement because it is only necessary to operate each switch once; that is to say, that after a car has left a switch, the switch has not to be operated again in order to break the circuit, as that is done by the action of the succeeding switch. In this way one-half of the difficulty of making a reliable switch is overcome, as the switch does not require to be held in position by any force, electrical or mechanical; it has simply to be moved to one position or another and left there.

A simple system of lever switches, however, will not be available for ordinary street work, and it becomes necessary

to devise some means whereby the switches shall be operated electrically and automatically. This is accomplished by the action of a cylindrical commutator, which is partially rotated, or rocked, by means of an electro-magnet.

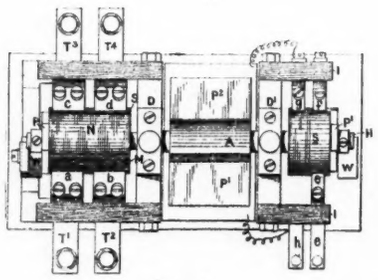


Fig. 2.

Fig. 2 is a plan of the apparatus. P^1 P^2 are the pole-pieces, and A is the armature of an electro-magnet, which is shown in elevation in fig. 3. N is a cylinder of insulating material, revolving loosely on the same spindle that carries the armature A. On part of the surface of this insulating cylinder are two metal plates, one of which serves to connect the contact springs *a* and *b* on one side, while the other will connect the contacts *c* and *d* on the other side. When *a* and *b* are connected by reason of the movement of the cylinder, *c* and *d* are disconnected, and *vice versa*, but the one pair cannot be disconnected until the other pair are connected, and thus there cannot be any sparking whatever at these contacts.

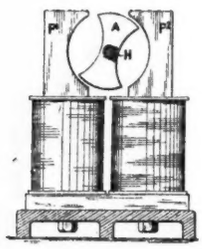


Fig. 3.

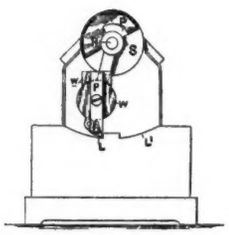


Fig. 4.

When the electro-magnet is energised, the armature will be turned to a horizontal position, and in turning will turn the commutator, N. This is effected in the following way. The spindle H, fig. 4, has attached to it the counterweight, W. The spindle is rigidly attached to the armature, A, fig. 3, but as already stated, the commutator, S, is free to revolve upon it. Part of the insulating cylinder, S, is cut away, and a quadrant projection, P, is fixed to the spindle, H. When, therefore, the armature of the electro-magnet is moved from a vertical to a horizontal position it will be able, on the one side, to move the commutator through a quarter turn, but on the other side, it will not do so, because of the half which is cut away. This cut away portion, however, permits of the armature returning to its normal vertical position as soon as the current in the electro-magnet ceases. If the armature were allowed to come to rest exactly in a vertical position, it would be attracted neither to one side or another when the magnet is energised, but it is prevented from doing this by means of a catch, L, at the end of the counterweight, W. The momentum of the counterweight carries it a little past the vertical position, and it is prevented from returning by the action of the catch on the raised portion of the plate, L^1. The result of this is, also, that the next time the magnet is energised the armature is certain to be attracted in the opposite direction, and thus an alternate motion from side to side is ensured.

The action of the electro-magnet is controlled by means of a small commutator, S, fig. 2, placed at the other end of the spindle, H, and working in exactly the same manner as the large commutator. The contact springs on the small commutator are so arranged that the electro-magnet can only be energised if the switch is set in the opposite direction to that which may be required for any particular surface stud.

The circuit through the electro-magnet is a shunt one, on the main conductors, one end of the coil being connected with a surface stud through the small commutator, and the other end to earth. The car, in passing along the track, makes contact with one surface stud before it leaves another. As soon, therefore, as it makes a contact with a stud in advance the current can pass down from that stud, through the electro-magnet of the corresponding switch, which will thus be operated, and will cut in the new surface stud and cut out the one which the car has just left.

It will now be seen that the system is fairly simple, both in the arrangement of the conductors and in the mechanism of the switch. The action of the switch is a simple rocking movement on one spindle, and there is no force required to keep the switch in position, as it is a simple change movement, and not a make and break. Moreover, the pressure of the contact brushes on the commutator is always the same, and is not affected in any way by the action of the switch. Another immense advantage lies in the fact that there are no working springs whatever, in fact it is difficult to see what there is in the switch which can possibly get out of order.

The switches are made to go into a cast-iron box 8 inches × 10 inches, with watertight covers. The cable connections pass in through watertight glands, and are so arranged that they can readily be disconnected, and the switch lifted out for inspection. Fig. 5 is a view of the apparatus in its box.

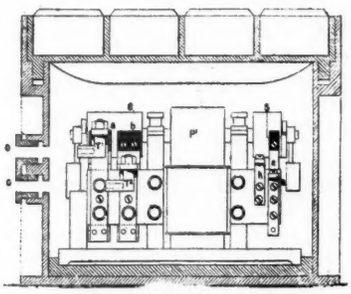


Fig. 5.

We suppose that it is impossible to make any apparatus which shall absolutely never fail. In this system, if a switch should happen to fail, the car could not proceed, and therefore the failure would be immediately discovered. It would be the work of a few minutes only to open the box and rectify or change the switch.

With this system the car is not required to carry any equipment in the way of electro-magnets or storage cells with which to operate the switches, and therefore it offers facilities in working the same cars on the overhead as well as on this system, as, for instance, where an underground system is required in a town, working in conjunction with an overhead in the suburbs.

The British and foreign patents for this invention are owned by Messrs. Kingsland & Edwards, of Manchester and Llandudno; and those who are interested in the matter may see the apparatus, which is now on exhibit at the Electrical Standardising, Testing, and Training Institution, Faraday House, Charing Cross Road, by written appointment to that address.

THE EMPIRE AND TELEGRAPH CABLES.

(*Concluded from page* 289.)

We have dealt with some of the more prominent of the objections which are now being revived against a cable through the Pacific. The "enormous depths" of this ocean, it will be seen, are now discounted, and we even find it put

forward, with an austere assumption of impartiality, that the great depth of water through which the Cape cable must pass would obviate the serious danger of interruption to which the existing lines to Australia are exposed in the shallow Java Sea. We quite agree with the opinion expressed that the present cables which pass through the Mediterranean would probably be rendered useless in case of warlike complications, as this did actually happen during the Egyptian war; but we would go still further, and point out that the same objection applies with equal force to several sections along the proposed Cape route, which, in places, would necessarily have to lie in very shallow water, and where they could be easily cut by the enemy. Take, for example, the section which would pass off Brest, where, for more than 150 miles, all the existing lines to Africa and the East are in water of less depth than 100 fathoms; and through this dangerous belt it is now seriously proposed to lay a strategic cable! In the case of the Pacific scheme any such danger is quite avoided.

To turn to another aspect of the new "supplementary" scheme, we find that to carry it out, some 13,700 miles of cable would be necessary, to which should be added 1,000 miles of landline from Cape Town to Natal. We also find that the cable would be landed in no less than 11 different places—almost all points of weakness—the last being the town of Perth in Western Australia. As opposed to this, we find, in the Pacific, that the length would only be 7,500 miles, and the landing places only five in number, lying in a part of the ocean little frequented by foreign vessels of war, the cable terminating between the towns of Sydney and Brisbane on the east coast of Australia. Should the cable bifurcate from Norfolk Island to New Zealand, an additional length of 450 miles will be necessary, and an additional landing place will be created. In continuation of this comparison, it should be borne in mind that the two existing cable routes to Australia converge at Java, and bifurcating thence, end; one at Port Darwin in the north of Australia, the other at Roebuck Bay, in the north-west of Western Australia. Thus we find that, to reach the centres of the greatest population, which lie in the east and south-east of the continent, telegrams have to travel over very great lengths of landlines. In the case of the Roebuck Bay cable there is a distance of about 3,300 miles to be traversed from that point before even Melbourne is reached, and more than 4,200 miles (about half the length of the Pacific cable!) before Brisbane is reached. Again, a telegram *viâ* Roebuck Bay, destined for the town of Burketown, in Queensland, has to travel over a length of landline which is greater than the distance between London and Calcutta, or several hundreds of miles more than the distance intervening between London and Vancouver. The land wire from the Port Darwin cable station is not so long, giving about 2,400 miles to Melbourne and 3,300 miles to Brisbane. It is now, we are told, proposed to land the "Cape" cable at Perth, the capital of Western Australia, which is more than 2,000 miles by landline from Melbourne, and over 3,000 miles from Brisbane. On the other hand, in the case of a cable landing on the Pacific coast of Australia, the main centres of population and commerce are within easy reach, Melbourne being only about 450 miles south of Sydney by landline, while Brisbane is about 520 miles to the north. The great importance of these figures will be at once evident, when we realise that the long landlines from Port Darwin and Roebuck Bay, the only means by which telegrams from Europe can be forwarded at present, have been interrupted on no less than 15 occasions during the last six months, the duration of each of these interruptions varying from a few hours to several days. In speaking recently of the Roebuck Bay landline, Sir Charles Todd, the Postmaster-General of South Australia, says, it "is acknowledged to be the worst line in Australia, the many fogs on the coast rendering it very hard to get signals through." It is thus clear that a Pacific cable would offer advantages which cannot reasonably be looked for, neither in the case of the existing cables, nor in that of the proposed cable from the Cape. The landlines in the compact group of colonies, Victoria, New South Wales, and Queensland, are numerous, and here reliance has not to be placed on long single wires, as in the cases above referred to. Duplicate communication with New Zealand can be easily assured by a short branch cable from Norfolk Island. The advantages above indicated are obvious, if we consider that the population in the south and east of Australia is about 4,200,000, who carry on a total export and import trade equal to about £120,000,000 annually, employing for this purpose some 17,000,000 tons of shipping. It would, therefore, seem beyond dispute that a cable landing right in the heart of this busy district is much more to be desired, and is much more worthy of support than one which would terminate in Western Australia; in which vast area (11 times the size of Great Britain) the total population, although increasing, is less than that of the town of Cardiff, and the trade and shipping correspondingly small, the exports and imports for 1896 being valued together at something over £8,000,000.

We propose to touch but lightly on the financial side of the question. We were informed through the press that the cable to be laid, *via* the Cape, is to be carried out in return for "certain privileges." Some light has recently been thrown on the nature of these privileges; one of which seems to be the payment of £25,000 per annum by the Cape Government for 20 years; another being the prolongation of the annual subsidy of £32,400 which has been paid by the Australian Governments to the Eastern Extension Telegraph Company since 1879, and which, if not renewed, will lapse in July, 1900. There may be other concessions which have not yet come to light.

It is a question whether the limits of modesty are not being overstepped, when we remember that one of the companies concerned, *i.e.*, the Eastern Extension Telegraph Company, has already received from Australasia, subsidies amounting to over £750,000; and that in the 10 years ending December, 1896, the annual receipts of this company, which are now about £640,000 (including subsidies), have increased by £187,459, and this notwithstanding a reduction in rates of about 50 per cent., which was only brought about under great pressure. An allied company, the Eastern and South African Telegraph Company, of which almost the entire capital is held by the Eastern Telegraph Company, has received in subsidies from various governments a total of considerably over £1,000,000.* It is not, perhaps, a cause of wonder that even a far-fetched attempt should be made to secure the continuance of similar "privileges," but we do not think that it is at all in the interests of the Colonies, or of England, to assist in the consolidation of any such monopoly.

We have dealt at this length with the subject, as it seemed only fitting and just that, however useful a cable to Australasia, *via* the Cape, may be, the claims to superior utility, both strategic and commercial, of a cable *via* Canada to Australasia should not be undermined by the circulation of misleading information.

CORRESPONDENCE.

Accumulator Testing.

Although your article on "Comparing Results of Tests on Accumulators" contains several hints to those engaged in testing accumulators, the writer seems to have omitted many equally important considerations.

If the accumulator is intended for lighting purposes, where constancy of voltage is imperative, it should in all cases of comparison be stated how thick was the acid space, or the distance between the plates.

Your contributor will find a marked increase in the steadiness of the pressure line with every fraction of an inch increase in the distance of the plates up to a limit ascertainable only by test for each kind and thickness of plate.

This is true of all lead storage batteries, but is, of course, most marked in those of the pasted type.

If the accumulator be intended for traction purposes, the acid space may be small, because a fall in pressure merely means a reduction in the speed of about the same percentage as is the fall in pressure.

One other point out of those named is the incorrectness

* The Aden-Zanzibar cable belonging to this company was interrupted all last week, thus completely cutting off the Cape from communication with Europe by the East Coast of Africa route.

of the assumption that the result from one positive can be used, all other things being equal, for accurately ascertaining the capacity, &c., of a complete battery.

Let your correspondent take three positive and five negatives of similar type and make them up into two cells of one positive and two negatives and two positives and three negatives respectively, and he will, after a few trials, see fit to modify his statement.

Even so far, however, as your correspondent goes, his article contains much that may be carefully followed by inventors and experts when testing batteries, and it may ultimately come to be understood that no two kinds, or even arrangements of the same kind of plate, will give results which can be tabulated on one basis, either of total weight, weight of single plates, weight of acid, or weight of so-called active material.

Appak.

Crowdus Storage Battery.

Referring to your article in the last ELECTRICAL REVIEW, I consider practical work of far greater value than academical figures. Some of these cells are now on the way here, and I shall be pleased to allow you, or your engineer, to make your own tests. Meanwhile, a perusal of the enclosed detailed description may be interesting to you. By letter just received from Mr. Crowdus, he states:—

"It seems almost incredulous, but these waggons have been going six days a week through the severe snows of the past two months, and in blizzards that severely crippled all kinds of traffic."

The waggon referred to is on page 16 of enclosed catalogue, which please return.

John T. Bowden.

[The figures called academical are unfortunately Mr. Crowdus's own figures. We also prefer practical work, and nothing can be more practical than careful, accurate, tests of a battery by a competent engineer. There are doubtless many professional experts to be found ready to test and report on this battery, and if the claims made for it can be supported by any one or more of these gentlemen, we shall be the first to congratulate Mr. Bowden. We publish on p. 381 the description referred to, from which it may be gathered that the cell is just what we all know as a pasted plate cell. The use of sulphate of zinc in the solution, and aluminium for the negative support, are doubtful improvements; at any rate, they require investigation by independent experts before being accepted as such. There is nothing surprising in driving waggons by electricity; it is easy enough if we put in plenty of cells of large enough capacity; but what we took exception to was Mr. Bowden's "academical figures," that waggons were driven 50 miles by a 3½ horse-power motor, with 44 cells of 100 ampere (hours) capacity; such an incredulous claim requires more support than the bare statements of the inventor. Mr. Bowden has put nothing before us of the slightest value in support of the extravagant claims made for his battery.—EDS. ELEC. REV.]

Parabolic Reflectors—An Anticipation.

I notice under the heading "The Institution of Electrical Engineers," an abstract of a paper entitled, "An Electrolytic Process for the Manufacture of Parabolic Reflectors," by Sherard Cowper-Coles.

I was quite interested in the account given, inasmuch as I practised substantially the same method of producing metal mirrors a number of years ago, and have the specimens of work now in my possession. My method was the same as that described in the paper referred to, viz., to take a glass surface, highly finished, and of the form of the reflector required, deposit upon it a silver coating, by any of the well-known silvering processes, such as are used for glass specula; follow this deposit by a heavy coating of copper, electrically made; separate the glass from the deposited metal; and, when needed, coat the face of the mirror with nickel or other metal resisting oxidisation or tarnish.

My object in developing the process was to replace the glass mirrors of searchlights, which are very easily fractured, but the process is undoubtedly a good one for making any accurate metallic mirrors.

I have had the silver coating leave the glass in such a high state of finish as to present the appearance of a vitreous surface. The least blemish or scratch in the glass surface is reproduced in the silver coating with absolute fidelity. I found that an easy way of separating the metal from the glass was by warming; the metal being more expansible than the glass readily separated when the warmth was sufficient. The deposited silver coating must be as free from pores as possible, otherwise there is a tendency for the copper-plating fluid to insert itself between the glass and the silver and blister.

Elihu Thomson.

March 2nd, 1898.

Sparking Coils.

Apparatus of various kinds for producing very long sparks have been lately described in your columns. I notice that in every case, while the length of spark is carefully stated, no measurement of the quantity of electricity yielded seem to have been made. The outputs were apparently guessed at. I designed some two years ago a simple instrument for measuring the quantity of electricity yielded by spark coils and similar apparatus.

In its simplest form it consists of a sensitive thermometer, on the bulb of which a small bobbin of thin insulated platinoid wire is mounted. The current from the secondary is passed through the bobbin for a known length of time, and the rise in temperature is noted. The heating effect may be taken to be proportional to the square of the current multiplied by the length of time the current has been passing. The instrument can be calibrated by passing a known current from a battery through the bobbin.

I have found that this instrument throws much light on the actions which take place in the various parts of the secondary winding.

G. Bowron.

March 14th, 1898.

"The Burning Question."

An original dissertation in the pages of the ELECTRICAL REVIEW, on the treatment of sewage sludge, could not fail to make very interesting reading, and I am sure you will not take offence if I add that the article on this subject, under the above heading in your issue of the 25th ult., is not merely interesting, but very amusing also. I hail the appearance of the article with great satisfaction. When the ELECTRICAL REVIEW voluntarily devotes so large a portion of its valuable space to a careful, even if utterly erroneous, investigation into problems connected with the disposal of refuse, and sewage sludge of all things, I feel convinced the time is not distant when the refuse destructor, which has hitherto, as you will allow, often received rough, and even disdainful, handling in the electrical press, will frequently find an honoured place in your pages. I do not mind even if your present article appears adverse in any way to a particular type of destructor with which I happen to be associated, when used for a particular purpose. It is sufficient for me that you are really investigating. Soon you will "discover" the refuse destructor, and we shall all be happy.

Meanwhile, you will recollect a description of a group of individuals who, if I remember rightly, "sat apart upon a hill retired," pursuing certain abstruse speculations, and became "involved in wandering mazes lost," and I greatly fear you also have become a little involved in your investigations in connection with sewage sludge. I am consumed by a desire to put you in the right path, therefore I beg to ask your reconsideration of the following proposition which occurs early in your article. The italics are mine. "The cost of burning is 1s. 6½d. per ton of pressed sludge. *Assuming that one-third of the weight of wet sludge has been removed by pressing*, this would amount to, say, 1s. per ton of wet sludge." This assumption is so delightfully naïve, that one hesitates to disturb it; but stern logic compels. I am obliged to inform you, therefore, that every ton of *pressed* sludge at Leyton represents eight tons of wet sludge; and instead of the "weight removed by pressing" being "one-third," as you artlessly assume, it is more than 87 per cent; instead of being only *one-half* that of the pressed sludge, it

is seven times as much. There is no mystery about it. The moisture in the *pressed* sludge is 60 per cent., in the wet 95 per cent. One of your young men would check the calculation. Consequently the cost of burning, when expressed in terms of the weight of the wet sludge, instead of being 1s., as you have estimated, is a fraction over 2½d.

You will easily see the absurdity of attempting to express the cost of any such process as the burning of pressed sludge, in terms of the wet sludge, if you consider that the moisture in the latter may vary immensely without making any appreciable difference to the cost of pressing, and none at all to the cost of burning. Thus, in the figures that you quote from Sir Alexander Binnie's report, the moisture in the wet sludge at Barking and Crossness averages about 91·00 per cent. Now, if this sludge were pressed as at Leyton, every ton of the pressed material would represent rather more than 4½ tons of the wet; the weight removed by pressing would be 77 per cent., or three and a half times as much as the weight of the pressed residue; and the cost of burning would be 4d., or 60 per cent. more than at Leyton, *expressed in terms of the wet sludge. The real cost of burning the material actually put into furnaces would be the same in both cases.* Of course, the impressive fabric which you have built upon your "assumption" must now come down.

"London," if she wished to press and burn her sewage sludge, would not require to expend anything approaching the extraordinary sum at which you have arrived. As a matter of fact, I do not know that anyone is seriously proposing that "London" should press and burn her sewage sludge. If at the time the present system was adopted by the late Sir Joseph Bazalgette, after a most complete series of experiments upon the pressing of the sewage sludge, one of which was adopted at my suggestion and superintended by myself on behalf of an eminent firm of Scotch engineers —if at that time there had been a destructor furnace whose capabilities in regard to the burning of sludge cake had been demonstrated like those of the Leyton furnaces have now been demonstrated; if also the question of destroying house refuse had attained the importance it has now acquired, then the problem of getting rid of the house refuse of London, or more particularly of the river districts, by using that refuse in that way to destroy the sewage sludge, thus getting rid of two huge nuisances at one stroke, would have been well worth the consideration of the authorities of that time. Even as it is, the possibility of such a combination is probably still worth the consideration of Sir Alexander Binnie. Leyton saves over £300 a year in coal in operations in connection with her sewage. The same rate would not apply to Barking and Crossness. If it did, over £18,000 per annum might be saved there; but, anyway, Sir Alexander Binnie could get all his mechanical operations at the Outfall Works done for a mere fraction of his present expenditure on coal, and have something considerable to spare. The idea is not new; Mr. Jones, of Ealing, I believe, proposed it at one time. But "it were well 't were done quickly." London refuse is rising in value. Soon none will be available for burning sewage sludge; it will all be in demand for producing electric light and power.

There are other texts in your article upon which I would have liked to descant, but I fear I have trespassed too much. I would, however, as you have referred to Mr. Jones, of Ealing, like to express my personal regret that there should have been the appearance, in connection with the recent celebration at Leyton, of a deliberate ignoring of Mr. Jones's claims in connection with the burning of sewage sludge. However crude one may consider the process at Ealing to be, it is unquestionable that to Mr. Jones belongs the credit of having first destroyed sewage sludge by burning upon a practical scale, and this acknowledgement is no more than the merest justice to him.

A. J. Liversedge.

March 3rd, 1898.

P.S.—The above was written before the appearance of Mr. Hetherington's letter in your issue of the 4th inst. Mr. Hetherington has put you right in reference to the "weight removed by pressing sewage sludge," but seems to have fallen into a remarkable misapprehension, to judge from his delightful account of what he imagines to take place at Ealing. He is not apparently aware that whilst the wet sludge is not "pressed" at Ealing as it is at Leyton, it is *drained* through house refuse—Mr. Jones devotes a certain proportion of his refuse to that purpose. What is the exact proportion of water so removed has not, I think, been stated. It will not, of course, be so much as the amount removed by pressing; but it is sufficient to bring down the process from the realms of the alchemist, where Mr. Hetherington appears to think it properly belongs—well, something after the prosaic style of Leyton.—A. J. L.

Rubber Cables.

The manager of the Burton-upon-Trent Gas and Electric Light Works a few weeks ago issued a circular to his colleagues of other towns. In this circular he stated that India-rubber covered cables of our manufacture had given him considerable trouble. As a letter of this description was likely to prejudice this company in the eyes of many, if dealt with as a confidential document, we had the circular reprinted and distributed, asking the recipients if they would take the trouble to furnish us with any replies they may have made to the original document. We have to thank a number of these gentlemen for their courtesy in replying. In answering, many informed us that they had not received the circular in question, others either had not replied to it, or were not users of our cables. Among the replies received from the users of our cables, six stated that they had some trouble either with the small or with the arc lighting cables, and in the majority of these cases the trouble was only temporary. Two wrote that they had no trouble whatever of a serious character, and the remaining 10 wrote that they had absolutely no trouble at all.

From the number of definite replies, we are well aware that these do not include reports from all the users of our cables for high tension distribution, as in some cases, where there was no cause of complaint, no replies were made, and, in other cases, where there has been, or may have been, trouble, we were not favoured with a copy of the report, if any, which was sent to Burton.

We hold that the statement reported to have been made by Mr. Alderman Lowe, of Burton-upon-Trent, and referred to in your issue of the 18th ult., must be incorrect, as the answers received to our circular show that, out of a total of 18, in 12 cases the cost of maintenance has been practically *nil;* and, as to the others, we understand the cost of maintenance has in no case been large.

We trouble you with this letter as the matter certainly is of importance to ourselves, and we believe it to be of interest to electrical engineers.

Wm. Gray,

Electric Light Department, The India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited.

Knots.

Having read Mr. Little's letter carefully I fail to see that the expressions "60 knots in length" and "12 knots per hour" are "inexact and wholly unscientific," and beg to differ when he says a *knot is a speed.* A knot is a measurement arrived at as follows: The circumference of the earth, 131,385,465 feet, is divided into 360 degrees, each degree being again divided into 60 parts or knots, consequently

$$\frac{131,385,465}{360 \times 60} = 6,082{\cdot}66 \text{ feet} = 1 \text{ knot},$$

6,080 feet being the length of the Admiralty knot.

A knot per hour is a speed expression in the same way as the expressions miles and miles per hour denote distances and rates of speed travelled by trains or other vehicles on land.

Mr. Little says the "word knot is used to denote an interval (length) between one or more marks on the log line." A log line being a length of line divided by knots spaced at intervals of about 50 feet, this spacing being chosen when the sand glass (used in taking speed measurements by this method) runs for 30 seconds, 50 feet bearing the same ratio to the length of a knot as 30 seconds does to an hour, viz., $\frac{1}{120}$th part (50·68 feet would be correct) but the fractional part is not considered as it is allowed for the wash of the wake of the vessel. Thus the

log line is a measurer of distance, as when in use the log ship (a triangular piece of wood weighted to keep it in a vertical position) remains stationary and the line is allowed to run out freely, the operator counting the knots in the line as they run through his fingers or over the rail, the number of knots which are counted being the number which have run out whilst the sand has been running through the glass for 30 seconds. This, of course, gives the distance which has been traversed by the vessel from the place where the log ship was thrown overboard in that period of 30 seconds. The log line, therefore, merely acts as a convenient scale for measuring a short distance travelled over in a given period of time, by which the speed per hour can be determined at once.

The whole question appears to be a quibble, as Mr. Little admits the use of the word knot to denote the interval between two particular marks on a log line, but will not permit it to be used to denote a distance which has been used for scores of years by naval officers and others, including misguided cable engineers.

Another Cable Engineer.

Testing Secondary Batteries.

In the communication on "Comparing Results of Tests on Accumulators," published in your issue of last week, I notice the following statement:—

"That constant rate of watts is the correct method is undoubted, for if we use a battery for power or traction, it may be called upon to work at the same rate at the end of 6 or 8 hours as at the beginning of the run."

Now, it would be interesting if your correspondent would let us know how a battery can be used in this manner. It probably could be done by some series-parallel arrangement of the cells, but surely the ordinary way of working in nearly all practical cases is to keep the *current* constant by switching in regulating cells or by cutting out resistance coils? Thus, although the watts *given to the motor* are constant, the watts *given out by the battery* are by no means so. To test a cell at constant current, therefore, seems the best method for present day practical purposes.

Albert Campbell.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the last meeting of the Institution of Electrical Engineers, held at the Institution of Civil Engineers on Thursday the 10th inst., the discussion on Mr. Binswanger Byng's paper dealing with 200-volt lamps and fittings was continued and concluded. It was not concluded, however, without repeated requests on the part of the president to speakers to be brief, while many desirous of throwing the light of their experience on the subject were relegated to the sending in of written communications to be printed in the *Journal*, and even then the hour of 10 had struck and gone ere an adjournment to the less formal, but equally interesting, discussion over tea and cake, was effected.

Prior to the re-opening of the discussion, the president, Mr. J. W. Swan, announced the preparation of a testimonial to M. Gramme, that a circular asking for subscriptions thereto was in hand, and that the inventor whose work in connection with the dynamo, everyone is aware of, and acknowledges, is to be banquetted at Brussels shortly. Strange to English ears, was the promise that donors of the smallest current gold coin would receive a bronze, and givers of a larger sum, a silver medal to commemorate the event, and, we suppose, reward those who assist the subscription list.

Mr. Stearn was the first speaker on the question before the meeting, and he gave his views at length. He had little to add, and nothing to retract from what he said in the discussion on Mr. Addenbrooke's paper,* as to the principles of high voltage lamp construction, and to show the exact position he held, and holds still, he quoted largely from his remarks in the *Journal of the Institution*. He considered the double filament is the most convenient as a transitional form, but that the zig-zag filament lamp met most requirements. Considering the material of the filament, he believed it has been shown that the change in candle-power is slower with low specific resistance; with high specific resistance a shorter filament can be obtained, which has the drawback of a rapid change in candle-power. But low specific resistance filaments can be used where some means of anchoring is adopted. He still considered that the type of high voltage lamp was best for a time, which suited most closely the conditions of the transitional period. Timidity in the use of high voltage supply was, however, dying out, and opposition to the change being gradually overcome. Lamps should be durable in the first place; reliable, so that there should not be premature breakages, while they should absorb the same amount of energy that one is accustomed to with the older and better known types. That the candle-power should be the same is merely desirable, and not at first essential; but small units, such as 5 and 8-candle-power lamps, should be forthcoming.

At the time when the high voltage was mooted, we were informed that fatal accidents and fires would be likely to occur at this tremendous pressure; but confidence is slowly giving place to suspicion. The lamps and fittings to-day do not meet every possible objection; but one must walk, if not yet able to run, and it is for this reason that at the time of the introduction of 200-volt lamps, the untreated filament seemed to meet the then requirements. The light curve is not everything. Carbon of an earlier period than that of the present day was rough, cindery and fragile, and the duration of use very short indeed. Treating was adopted to patch up irregularities, and fit the carbons for commercial use. About 1881 a number of lamps were made up, half with treated and half with untreated filaments, and tested by Mr. Crompton. None of the treated filaments were readily broken, but the untreated gave way rapidly. The process, devised by Mr. Swan, of projecting a jet of cellulose into a setting solution is now generally used for the manufacture of filaments, and lamps can be made of any reasonable efficiency. Those made in this way are better and more reliable than if treated. Equal diameters and very nearly equal resistances can be depended upon. When the treating process has once been begun one is liable to variations in specific resistance, diameter and emissivity, or the radiating qualities of the surface, and changes occur from any difference in the temperature, pressure, or kind of hydro-carbon used, and many other things.

A treated filament for a high voltage lamp may be from 14 to 15 inches long, and it cannot be safely used unless some special mode of disposing of it be provided, as it really is a very flexible pendulum. But if some such disposition be not adopted, Mr. Stearn would prefer to use the untreated filaments. The fears of the public have now passed away, but they prefer lamps of long life. The factor of convenience is often overlooked. Suppose the life curve does fall, the user has the option of replacing lamps as he pleases. Mr. Stearn was surprised to hear that one lamp in a dozen was expected to short circuit at once, but this may not represent the general conception of what such lamps do. There are two causes of short circuiting: a fertile cause is the entanglement of the double filament in transit, and if this defect be not noted trouble must ensue. Another is an accidental crack in the bulb. Externally the short circuits may be due to bad capping or carelessness in using soldering fluids, or in frosting with chemicals. Internal shorts are more attributable to careless exhaustion. This should be utterly impossible. When the change was made from 50 to 100 volts, it was thought that the space between the terminals should be doubled, but later experience showed this to be quite uncalled for, and the distance between them is amply sufficient for much higher pressures if the vacuum is properly made and permanent. Mr. Stearn has not been able to discover any reason for making any difference in exhaustion or the mode of doing it. The gas to be removed is not from the filament alone, but comes, also, from the soldered ends and from the platinum.

A rise in candle-power is entirely in the hands of the lamp maker, and at one time it was thought best to do away

* "High Voltage Lamps and their influence on Central Station Practice," Mr. C. H. Stearn's remarks in discussion, p. 271, No. 122, Vol. 25, *Journal Institute Electrical Engineers*, March 12th, 1896, also *Proceedings Municipal Electrical Association*, parts of 1896 issue.

with it entirely. But rise can be kept at from 16 to 17 or 17½ C.P. in 300 hours, made to expend the excess during the useful life of the lamps. By this means a better average is obtained from the lamp during its life. Accuracy in classification, rather than cheapness in the lamps, and the maintenance of an average standard efficiency for all voltages were, the speaker believed, highly desirable. Until that accuracy is reached, lamp making cannot be an exact science.

Mr. Stearn did not see why stations should not go up to the highest pressure permitted by the Board of Trade, and even calmly spoke of 500-volt lamps for street lighting. On the question of alternating and continuous current, he suggested that if the vacuum was not absolutely perfect, lamps may last longer with alternating current. Some figures were given showing that the breaking strain for treated was less than for untreated filaments.

Mr. Crompton stated he laid out Harrow for 200-volt supply three years ago. The lamps were wholly satisfactory, and he had found no difficulties, as he had proceeded on Mr. Stearn's lines and advice. The users seemed to be as well satisfied as any 100-volt consumers, while the extreme ease of regulation and every other advantage of high voltage has been obtained. He had made tests of switches for the Council of the Institution, and at first hoped to be able to prepare a table of lengths of break for different pressures and currents, but the results proved unsatisfactory, as very short breaks on a particular form of switch gave better results than longer breaks on other patterns. He is decidedly of opinion, however, that larger covers are wanted. With fuses the perforations in the cover minimise the arcing effect. It is a very excellent idea to use plaster of Paris round the wire as Mr. Binswanger Byng does. In prescribing a twin wire one can get no further than the tests and specification given in the Institution wiring rules. It is, therefore, unnecessary for that matter to be gone into further.

Mr. Swinburne had found that one might put an N.B. into text books of chemistry to the effect that "the real chemistry may be quite different." He amused the audience by a most interesting and crisp contribution to the discussion in his best form, and our only regret is that so much is lost in attempting to convey in cold type what is so well worth listening to. He reminded those present that Ferranti had in 1885 proposed to use 500 volts, and as the representative of the Hammond Company he supposed he would have had to make the lamps had they been required. After a few remarks as to carbon, he mentioned that certain carbonised animal fibres give nearly the same resistance hot as cold. We believe we are correct in saying * that Mr. Swinburne holds the opinion that efficiency and temperature go together in lamp making. In the classical trial, Edison-Swan *v.* Holland, he was in a minority of one in this opinion, being considered as on the one hand a biassed witness, and on the other a lunatic!

Mr. Wordingham gave the results of his Manchester experience, thought small arc lamp users must not be overlooked, had received no complaints, reminded the profession of his warning that 100-volt fittings would not be safe on 200 volts, and described his tests for fuses and switches of overloading them by 50 per cent. both on current and pressure factors.

Mr. Rawlings delivered a most amusing speech on his relations with 200-volt consumers. It was painful to meet those who had gone over from lower pressures to higher, but quite a pleasure to see those who knew no better than 200 volts. Some houses have no less than four separate voltages to meet piano lamps in series, &c., and many were the troubles Mary Jane, his clients, self, and supply company had to meet. Lamps he found certainly unsatisfactory. The next speaker went into lamp manufacture in detail, and was followed by Mr. Swinton, who pictured the cathode ray lamp without a filament. He adduced the fact, not known to all, that in a high vacuum the nearer two conductors are together the greater the resistance. Even 20,000-volt lamps for street lighting, with a separate transformer to each might come.

* Mr. Swinburne later in the evening protested against a statement that he had said that efficiency depended only on temperature, which is by no means the idea he conveyed by his speech.

Mr. H. W. Miller told an unvarnished tale of certain complaints as to lack of light with high-volt lamps and the deterioration that occurs. He disagreed with the author as to the action on the blowing of a fuse, and thought that when a fuse melted the hot air and metallic vapour rushes out of the holes in a pattern such as described in the paper. Mr. Robertson stated that the advantages of carbon were so many that lamp manufacture must remain where it is until some substance other than this is found for filaments. He dealt with the controversy, treated *v.* untreated filaments, and methods of manufacture at some length.

Mr. Geipel, Prof. S. P. Thompson, Mr. Grimshaw, Mr. Addenbrooke, and the president proceeded with the debate, and then Mr. Byng rose to reply in brief. These speakers reiterated and enlarged upon the questions which had already been treated by others in part, and although what was said was extremely interesting, we think the accounts of the proceedings in the forthcoming *Journal* will be sufficient to satisfy all our readers that ample justice was done to an excellent paper.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending March 17th, 1897.	£	s.
Alexandria	50	0
Amsterdam	200	0
Antwerp	21	0
„ Elec. fuses ...	307	0
Baltimore. Teleph. mat.	50	0
Bombay	24	0
Bushill. Teleg. mat. ...	33	0
Calcutta	88	0
Cape Town	335	0
Christiana. Teleg. wire	45	0
Colombo	10	0
Copenhagen. Telg. wire	20	0
Durban	793	0
East London	279	0
Genoa	160	0
Gothenburg. Teleg. wire	310	0
Hong Kong	14	0
Jersey. Teleg. poles ...	14	0
Lisbon. Teleg. mat. ...	12	0
Melbourne	45	0
Ostend	33	0
Paris	10	0
Rangoon. Teleph. mat.	48	0
Shanghai	63	0
Singapore	75	0
Stockholm. Teleg. mat.	125	0
Sydney	1,638	0
Wellington	337	0
Yokohama	2,000	0
Total ...	£7,142	0

Week Ending March 17th, 1898.	£	s.
Adelaide	10	0
Albany	43	0
Alexandria. Teleph. mat.	49	0
Amsterdam	300	0
Bangkok	89	0
Bombay	50	0
„ Teleg. cable ...	670	0
Boulogne	24	0
Buenos Ayres	81	0
„ Teleg. mat.	310	0
Cape Town	820	0
Colombo	78	0
Delagoa Bay. Teleg. mat.	3,710	0
Demerara	58	0
Durban	714	0
Flushing	14	0
Fremantle	30	0
Gibraltar	121	0
Gothenburg	171	0
Hong Kong	10	0
Key West. Telg. cable	1,400	0
Launceston	11	0
Lisbon	425	0
Madras	107	0
Malaga	334	0
Malta	16	0
Melbourne	59	0
New York. Teleg. mat.	525	0
Ostend	65	0
Port Elizabeth... ...	51	0
Stockholm. Teleg. cable	60	0
Sydney	186	0
Wellington	445	0
Total ...	£11,036	0

Application for Extension of Patent.—On March 30th, at 10.30 a.m., the Judicial Committee of the Privy Council will hear the petition of the Hon. C. A. Parsons for an extension of the term of the letters patent granted to him on April 23rd, 1884 (No. 6,735), for "an invention of improvements in rotary motors actuated by elastic fluid pressure, and applicable also as pumps."

Australian Electrical Work.—From a Sydney engineering exchange we learn that the Brush Company is busy in that part of the world. The company is supplying an electric pumping plant for a Lithgow (N.S.W.) colliery company, and is now erecting electric light plant for the Sydney electric light station.

Bankruptcy Proceedings.—An application was made last Friday to Mr. Registrar Brougham, at the London Bankruptcy Court, for an order of discharge on behalf of John Orme, scientific apparatus manufacturer, Cross Street, Finsbury. The bankrupt, in 1893, promoted Orme's Electric Signal Company, Limited, to take over his patent electric fog signal. As vendor he received £6,000 in shares, which, however, proved valueless, as the company went into liquidation in 1895. He failed in November last with liabilities, £1,769, and a dividend of about a 1s. in the £ will be paid to the creditors. The failure was partly attributed to the loss and liabilities incurred in connection with the fog signal company. Three offences were reported by the Official Receiver, and the learned Registrar imposed a suspension of two years and a half.

Bankruptcy Proceedings.—Under the failure of Trehearne Son & Crump, electrical engineers and contractors, 155, Fenchurch Street, E.C., the first meeting of the creditors was held on Wednesday, at the London Bankruptcy Court before Mr. Wildy, official receiver. The accounts show liabilities £1,066, and assets, £413. The business was started by Mr. Trehearne in June, 1895, and in May, 1897, Mr. Crump became a partner, introducing a capital of £750. Disputes arose between the partners as to the position of the firm, resulting in the present proceedings. In January last an electrical engineering company was formed by Mr. Trehearne and his friends, which took over the firm's offices, and appointed him (Trehearne) as managing director with a commission on the profits. When the firm stopped there were some contracts on hand, but they were abandoned. The failure was attributed by Mr. Trehearne to losses by betting, heavy expenses incurred in getting business, loss on trading and bad debts. Mr. Crump, on the other hand, attributes it to the failure of his partner to carry out his guarantees relating to the liabilities of the business when the partnership was formed. No offer was made to the creditors, and Mr. B. T. Norton (Pratt and Norton), accountant, Old Jewry, E.C., was appointed as trustee to wind up the estate in bankruptcy, assisted by a committee of inspection.

Business Announcement.—Messrs. J. C. Lyell & Co., of 55, Victoria Street, announce that increased business has compelled them to take *all* the offices at the above address, which is now occupied solely by them. They are shortly about to open several new departments.

Catalogues.—Mr. A. P. Lundberg, of Bradbury Street, Kingsland, has brought out a catalogue which is a credit to both printer and compiler. The setting out of the cover is very neatly done, and it is printed in green and gold. In the 28 pages of letterpress and illustrations, Mr. Lundberg lays before his customers and the trade generally particulars of his numerous types of switches, wall connections, wall plugs, distributing fuseboards, cut-outs, ceiling roses, &c. Many of these fittings have already been described in our columns, and are well known to the electrical trade. Mr. Lundberg has given a good deal of attention to high voltage fittings, and has introduced some new patterns embodying high voltage requirements.

A list has been issued by Messrs. W. O. Rooper & Robins, electric light engineers, of 3, Newgate Street, Chester and Stafford, in which they give a list of electric lighting and power contracts carried out by them in various public works, country houses, business establishments, residential premises, &c., in the provinces.

Messrs. Schischkar & Co., of 67, Stafford Street, Birmingham, and Nottingham, who are sole agents for the L. W. Pond Machine Company, of America, send us an illustrated list of the English and American machinery and tools they have in stock in this country. The list shows lathes, drilling machines, chucks, also milling, emery grinding, and shaping machines, as well as various other engineers' tools.

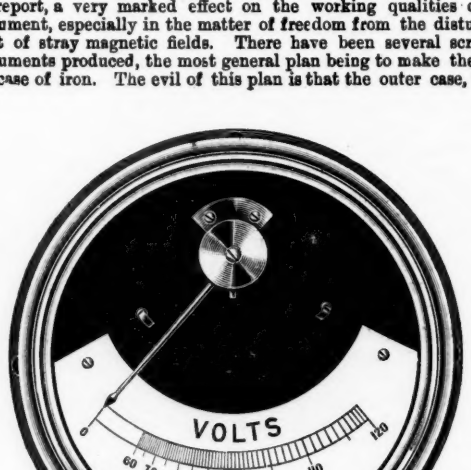
Change of Address.—Mr. S. Harrison, late of Ellesmere Works, Newtown, and 697, Ormskirk Road, Pemberton, near Wigan, announces that he has taken over new showrooms, offices and works, at 73, Wallgate, Wigan, where he will carry on business in electrical accessories, switchboards, incandescent lamps, arc lamps, fittings, &c. Mr. Harrison has been appointed sole agent for the North of England for the Crescent arc lamp and the Hard incandescent lamps. All letters should be sent to the new address.

Change of Name.—The business formerly carried on at Maritzburg by the Excelsior Electrical and General Engineering Company is now being conducted under the name of Messrs. Brady and Wyles, electrical engineers, at 192, Church Street, Maritzburg. The firm has recently carried out some important electrical contracts in that city, including three private plants—one for the Government Laboratory at Allerton, and two other Government contracts.

Coke v. Richardson.—In the Westminster County Court on Tuesday his Honour Judge Lumley-Smith, Q.C., tried the case of Coke *v.* Richardson, which was a claim for £20 odd for work done by a gasfitter and plumber of Whitcombe Street, W., against the defendant, an electrical engineer, of Southport. Evidence was given that defendant was fitting an electrical installation at the Clarence Hotel, Charing Cross, and a gas engine was to be used. Other work was required, and plaintiff did it. The defence was that part of the work had been done upon the order of Mr. Buxton, the owner of the hotel, and that plaintiff had rendered an account to him, and that all that was due to the plaintiff had been paid to him. His Honour found that the question of the work was really between Buxton and Richardson, and that the latter was liable to the plaintiff. There would be judgment for the plaintiff for the amount claimed with costs.

Commutator Bars.—The Forest City Electric Company, of Cleveland, O., has issued an 1898 railway catalogue of roll drop and drop forged commutator bars. The list contains details of bars for Westinghouse, General Electric, Edison, Walker, and other railway motors.

McWhirter's Patent Shielded Instruments.—It is interesting to notice the tendency among instrument makers and users to revert to the permanent magnet in the manufacture of ammeters and voltmeters and other electrical measuring instruments. The causes underlying this change are twofold: Firstly, there is no doubt that the production of finely made instruments constructed on the D'Arsonval principle has tended to bring permanent magnets into favour, not because they are any better or more reliable than they were 10 years ago, but because instruments of this class possess so many good qualities that the main objection, viz., the unreliability of the best of magnets, has been lost sight of, and on all hands we hear of engineers using such instruments as standards, regardless of the fact that they are only fit for secondary standards. As such, instruments of the D'Arsonval type are admirable, but it should never be forgotten that occasional comparison with an absolute standard is essential. The second, and, perhaps, the main reason for this reversion is the failure of electro-magnetic instruments to meet the demands of electrical engineers. The need for accurate measuring instruments is ever increasing, and electro-magnetic instruments, in spite of the paramount advantage of permanence, fail in many respects to meet this great want. The engineer expects his instruments to give accurate results under all conditions of temperature and in stray magnetic fields of great and ever-varying strength, and as the field of the average electro-magnetic instrument is comparatively weak, the stray field due to leads carrying, say, 200 amperes and upwards has a very substantial effect; also, in cases where the switchboard has to be close to the dynamo, there may also be a very serious disturbance. In some cases these troubles can be avoided by careful design, but in most cases this is impossible. The instruments which are described below lead us to hope that the electro-magnetic instrument is beginning to move faster towards perfection than it has been doing lately, for in them some of the most serious drawbacks to their class are either removed or greatly reduced in importance. Mr. McWhirter's invention is very simple, and consists in the substitution of an ironclad bobbin for the ordinary brass one. This modification, although so simple, has, as Prof. Jamieson has shown in his report, a very marked effect on the working qualities of the instrument, especially in the matter of freedom from the disturbing effect of stray magnetic fields. There have been several screened instruments produced, the most general plan being to make the outside case of iron. The evil of this plan is that the outer case, being



irregular in shape and thickness, and having of necessity an opening through which the scale can be read, becomes polarised, and thus the screen itself becomes a source of the very disturbance it was designed to guard against. In the case of Mr. McWhirter's screen, the iron case is placed on the coil only, and, moreover, forms a part of the magnetic circuit; being of even thickness and symmetrical shape, it is not at all liable to polarisation, and as the outer iron coat is ¼-inch thick, the shielding is almost perfect, as shown in the tests. It may be thought that such a mass of iron would produce a great increase in the error due to residual magnetism; but this is not so, as the tests show the error is no greater than in the case of the ordinary instrument with which it was compared, and more recent instruments give results considerably better than this. The ironclad coil possesses other advantages, chief among which is the great reduction in the power necessary to work the instruments. The power used in a McWhirter voltmeter is only one half of that necessary to work a corresponding voltmeter with an ordinary coil, and it is thus possible to wind the coils either entirely of manganin, or with a much larger proportion of this alloy than is possible when a greater number of watts are necessary, consequently the errors due to internal heating and to changes in atmospheric temperature are reduced to an insignificant amount. Tests have been carried out by Prof. Jamieson, which show clearly the advantages obtained by adopting the McWhirter coil in the manufacture of electrical measuring instruments. Comparisons of the resistance when hot, after a 20 hours' run (5,112 ohms), with the resistance when cold (5,082·5 ohms) showed the error due to this cause to be very slight, amounting in all to only ·58 per cent. While the voltmeters were indicating approximately 100 volts, a horse-shoe magnet was placed so as to produce a maximum deflection of the pointer, which was noted; the poles of the magnet were then reversed, and the deflection in the opposite direction noted. The mean of the two readings was taken as the percentage error due to the external magnetic field.

The McWhirter voltmeter gave an error of...	0·75 per cent.
The ordinary voltmeter	6·00 „
A new engine room volt gauge	5·00 „

Prof. Jamieson summarises the tests as follows:—"I have to report that your newly patented shielded voltmeter is less affected by external magnetism than any other electro-magnetic one which I have seen. The temperature is also negligible, being only ⅓rd of 1

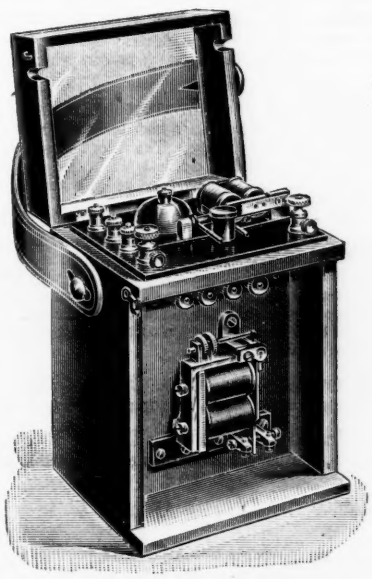
per cent., at 100 volts, after 20 hours in circuit." The General Electric Company, Limited, of Queen Victoria Street, London, and Peel Works, Manchester, are the sole licensees and makers of these improved shielded instruments.

The National Telephone Company v. Atkinson and Day.—In the Queen's Bench Division on Tuesday, before Mr. Justice Day, the case of the National Telephone Company *v* Atkinson and Day came on for hearing. Counsel's statement disclosed a curious state of facts. The action was brought to restrain the defendants from cutting, or otherwise interfering with, the plaintiffs' wires. It appeared from counsel's statement that the first defendant, Atkinson, was a tailor, carrying on business in the Fulham Road, and for a number of years telephone wires had been carried above his premises. In October of last year he had a conversation with the second defendant, Day, who asked him why he did not get a rent from the telephone company for allowing the wires to be carried over his house. Day suggested 2s. 6d. per annum per wire as rental, and stipulated that if he received this sum he was to have 25 per cent. of the proceeds. Atkinson agreed to this, and Day accordingly wrote to the company. They not replying he wrote again, threatening to cut the wires, a threat which, it afterwards transpired, was made wholly without Atkinson's authority, and, in fact, against his wish. In face of this threat the telephone company came to the court and obtained an interim injunction. It was then suggested that the motion should be treated as the trial of the action, and the plaintiffs agreed to this course provided that Day, who was in the wrong, paid the costs incurred. This he would not do, so the action went on. Counsel for the plaintiffs called Mr. Atkinson the first defendant, who bore out the opening facts, and said he never authorised Day to threaten to cut the wires. The wires had been over his house for 10 years, and he had never suffered any inconvenience therefrom. Mr. Day gave evidence on his own behalf, stating that he did not care about the injunction, as Mr. Atkinson had withdrawn his authority, he could not possibly do anything. The only thing he objected to was paying the costs. The injunction, so far as he was concerned, was not worth waste paper. Mr. Justice Day said he did not see how Atkinson could proceed with his claims to get a rental unless he had been prepared to cut the wires. The best conclusion he could come to, was to find for the plaintiffs, without costs.

Personal.—It is stated in an Aberdeen paper that Mr. W. McWhirter, M.I.E.E., of Aberdeen, is sailing for India on 25th inst., to carry out a new system of electrical train signalling. He will afterwards proceed to Cape Town on the same business. During his absence his electrical engineering business in Glasgow will be carried on by his son, Mr. Anthony C. McWhirter, A.I.E.E.

Pritchetts & Gold.—This firm ask us to state that in future all their correspondence in connection with the manufacture of storage batteries will be conducted from their works at Feltham, Middlesex, to which address all communications relating to that portion of the business should be forwarded.

Receiver for Wireless Telegraphy.—We illustrate below a new receiver for wireless telegraphy, which is being made by Messrs. Miller & Woods, of 2, Gray's Inn Road, W.C. This, we understand, has been provisionally protected by Mr. L. Miller. The chief



novelty is the method of decohering. The coherer is attached to the middle of a stretched wire, on which two small rods of metal, with a screw thread cut on them, play like a fiddle bow on the strings. The small rods are attached to the armature of an electro-magnet thrown into action by a relay. The decohering action, therefore, begins directly the armature moves, and continues for its whole motion to and fro. Mr. Leslie Miller showed some experiments in signalling without wires at the Institution of Junior Engineers' conversazione last Saturday, and on that occasion no shunts whatever were used to prevent the spark of the relay influencing the coherer, but the bell only gave single rings. The coherer used consisted of an ebonite cup, in the inside of which there were some nickel filings bridging over a $\frac{1}{8}$th-inch gap between the ends of the stretched nickel wire. The method of decohering can, however, be applied to the Marconi coherer, or most other forms. The apparatus shown is intended for lecture purposes. For working over long distances a more sensitive relay is required than that shown in the illustration.

Utilisation of Water Power in Italy.—It is reported that Messrs. Ganz & Co, of Buda-Pesth, have acquired the rights to utilise the water power of the river Tanaro, in the province of Piemont, and plant is to be put down to generate and distribute electrical energy for lighting and power purposes in the neighbourhood. It is stated that 2,000 H.P. is available.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Town Council has sent back to Committee the proposal to charge 6d. for the first hour daily of the maximum demand for current for power purposes, and 1½d. per unit after. At the last meeting, the electric lighting accounts for the year 1897 were submitted by Councillor Johnston, who said that since the new system of charging had been adopted, a good many complaints had been received from consumers who formerly paid 5d. on the first hour's consumption, and were now charged 6d. The system, which had been adopted by other corporations, was introduced last year. He did not wish to characterise the class of consumers from which the complaints came as the consumers, but they did not pay the department so well as those who came within the scope of the rule as to the rebate; and the committee had acted in as equitable a manner as they could. During the past six months they had had a rather heavy expenditure through changing the system. The engineer informed him that during the past half year there had been something like £300 spent in connection with the change of system, which would not occur again for a considerable time. Had it not been for that they would have had a good balance.

Barton-on-Humber.—The following from the *Leeds Mercury* of the 10th inst. will interest electrical firms:—"Wanted, electric light installation at Barton-on-Humber. This is a thriving manufacturing town of considerable importance, at present inadequately served by a small private gas company with exorbitant charges. A local syndicate is prepared to render considerable financial aid, and would also give other assistance which would be of value to the promoters of such a scheme. Address C, 190, Mercury Office, Leeds."

Barking.—The Board of Trade has written to the District Council inquiring whether the undertakers of the electric lighting order proposed to connect the intermediate conductor of their three-wire system of mains with earth. The Board pointed out that the concurrence of the Postmaster-General was necessary for an earth connection.

Belfast.—The engineer recently reported that machinery and boilers for the new electric station were being delivered and placed in position, and he hoped to have the first section of the establishment in working order shortly.

Blockley.—A copy of an order served on Mr. H. N. Warburton, owner of the electric lighting installation at Blockley, has been received by the Parish Council from the Board of Trade, together with the regulations as to the installation.

Bradford.—The Mayor submitted the gas and electricity accounts for the half-year at the last Council meeting. Regarding the electricity department he said that the total income for the half-year ended December 31st, 1897, was £10,842 0s. 7d., as compared with £9,570 13s. 2½d. in the corresponding period in the previous year, or an increased income of £1,271 7s. 4½d. The total expenditure for the half-year, which included interest and sinking fund, was £7,942 18s. 8d., against £5,570 4s. 1d. for the corresponding period. The profit for the half-year was therefore £2,899 1s. 11d., as against £4,000 9s. 1½d. for the similar period of 1896. The decrease in profits of £1,101 7s. 2½d. as compared with the corresponding period, was explained chiefly by the increased interest and sinking fund charges, amounting to £885 extra, together with sundry items of repairs to machinery, including renewal batteries, &c. The number of consumers was at present 640, as against 470, or an increase upon the corresponding half-year of 36 per cent. The total number of units consumed was 550,300, against 477,342, or an increase of 15¼ per cent. The total profits since the opening of these works, in September, 1889, to December, 1897, after paying interest and sinking fund, amounted to £16,733 0s. 6d., and the total amount written off for depreciation had been £7,307 15s. 6d., leaving the sum of £9,425 5s. to be appropriated as the Council might direct. The trade profit, *i.e.*, the profit before charging interest and sinking fund, was £4 11s. 9½d. per cent. for the half-year on the capital outlay. The net profit, *i.e.*, after charging interest, sinking fund and depreciation, showed £1 2s. 7d. per cent. for the half-year. Taking the December and June half-years together, the trade profit was £11,234 10s. 1d., representing £8 3s. 3d. per cent. per annum on the capital outlay. He thought this was a reasonable report, and that the Council had reason to be satisfied with the working of the department.

Brewery Lighting.—Messrs. Polkinghorne & Co.'s new brewery at Mutley is to be lighted electrically, and Messrs. Lord and Shand are putting down a Taunton dynamo for supplying 260 8-C.P. lamps.

Brighton.—The Town Council on Monday decided to reduce the price of electricity from 1½d. per unit after the first hour to 1d. The change, it is stated, will not take place for three months. The lamps in Dorset Gardens, are in future to be lighted by electricity instead of gas.

Bristol.—The Electrical Committee decided on Friday last to reduce the charges for electric current for power purposes, subject to a special agreement being entered into, from £6 per annum per kilo. installed, to £5 per annum per kilo. demanded where the customer has no private plant on his premises, and £5 per annum per kilo. installed where the customer has a private plant. It was also decided to reduce the charge for electricity consumed for motive power from 2d. to 1½d. per unit, subject to a sliding scale of discounts varying from 2 to 15 per cent. The Local Government Board has sanctioned the borrowing of £23,000 for public electric lighting. Mains are to be extended in various thoroughfares.

Buenos Ayres.—On February 12th the tenders for the public lighting of the City of Buenos Ayres were opened. A tender for electric light was presented by the City of Buenos Ayres Electric Light Company, and for gas by the New Gas Company, and the River Plate Gas Company. These tenders are, says the *Review of the River Plate*, more or less the same as those presented on a previous occasion, and it is possible that they will not be accepted. The Municipality evidently desires to get the public lighting done for nothing, and our contemporary recommends the authorities, if they desire to receive tenders that will benefit the city, to pay their gas and electric light bills when they fall due. Cash payments will soon bring about cheap gas and electricity.

Burton-on-Trent.—At the last meeting of the Council, Alderman Lowe said with reference to the defects in their electric lighting service, they had had Mr. Bailey (the engineer of the Metropolitan Electric Lighting Company) down from London, and he had made an exhaustive inspection of their appliances, but up to the present his report had not been received.

Buxton.—Prof. Kennedy has been instructed to prepare plans and specifications, and obtain tenders, for a municipal installation. The cost of the plant necessary for 6,000 8-C.P. lamps, and the necessary trunk and distributing mains—will be £12,500; buildings, £3,000; meters and house service £300.

Carlisle.—The Council has accepted the tender of Mr. John Laing, Carlisle, for the erection of the electric light station for £7,668.

Cheltenham.—The electrical engineer's report for February shows the total number of services connected was 241, with an equivalent of 14,600 8-C.P. lamps. He is reporting as to the means of improving the lighting of certain roads by arc lamps. The secretary of the Ladies' College recently complained of the large increase in the account for electric supply to St. Hilda's for the last quarter, amounting to £40 odd for 2,027 units, whereas for the corresponding quarter last year the account was £28 odd for 1,195 units, although the number of lamps in use was the same. The electrical engineer having inquired into the matter, reports that he has tested the meters, and in his opinion the principal reason for the large increase was the lavish use of the lamps and want of care in switching them off when not required. The gas manager does not consider the incandescent gas burner is yet in a satisfactory condition for street lighting.

Country House Lighting.—Kedleston, Lord Scarsdale's house near Derby, is to have the electric light. There will be a steam plant, with "D.P." accumulators, and about 250 lights fixed at present. The work has been entrusted to Messrs. Drake & Gorham.

Crickhowell.—The Parish Council is to consider whether to go in for electric lighting or to construct new gas works.

Crieff.—A report was recently furnished to the Town Council by Mr. R. F. Yorke, as to forming a company for providing electric light for the town—the motive power for which is proposed to be supplied by the Falls of Turret, some three miles north-west of the town. Mr. Yorke says that the available head is from 500 feet to 600 feet.

Darfield.—The District Council last week decided to apply for an electric lighting provisional order.

Fareham.—The District Council has decided to apply for power to borrow £2,900 for the purpose of adding to the electric light plant. It was pointed out that the proposed expenditure would provide a second plant for use in case of breakdown, and also for any increase in the demand for the light.

Glasgow.—The Electricity Committee recommends the expenditure of about £20,000 on dynamos and engines, lead-covered cables, &c., required for the new electric lighting station at Port Dundas, and for the more complete equipment of the existing station.

West Nile Street is to be lighted with electricity by means of lamps suspended from the trolley poles.

Glossop.—At the last Town Council meeting, the Town Clerk said he had received applications from three consulting engineers regarding the electric light scheme. The applications were referred to a sub-committee.

Greenock.—Mr. Teague's electric lighting scheme, which includes lighting the principal streets by means of 40 2,000-C.P. arc lamps, also the lighting of the James Watt Dock, was before the Corporation last week. The estimate is £27,500, exclusive of cost of site. The estimated revenue is about £3,300, and the expenditure: —interest on capital, £750; management expenses, £1,650; depreciation, £900. A Corporation site in Hunter Place has been selected. The Corporation adopted the scheme.

Hackney.—The Vestry has received letters from several electrical firms in reference to the electric lighting scheme, but only those schemes will be considered which were received in accordance with the published advertisement. Mr. A. T. Snell has offered his services in connection with the scheme, and his letter is before the Electric Lighting Committee.

Hampstead.—The question of electric lighting for the new workhouse buildings is in the hands of the Works' Committee.

Japan.—Of the 42 largest cities in Japan, from Tokio, with 1,368,000 population, down to those of 26,000, electric lighting systems are installed, says *Daily Tenders and Contracts*, in 24 only.

Leeds.—The *Yorkshire Daily Post* says that the Yorkshire House-to-House Electric Supply Company has refused the price offered by the Parliamentary Committee of the Leeds Corporation for its undertaking. The proposal was to give the company £210 2½ per cent. Redeemable Leeds Corporation Stock for every £100 which may have been properly expended on capital account. In view of this refusal it is understood that the Corporation will proceed with their provisional order, by which they seek power to issue 5 per cent. Irredeemable Stock.

London.—The St. George's Vestry has received a letter from the Board of Trade, stating that as the Brush Electric Lighting Company had elected to proceed with the works authorised by their provisional order of 1892, the Board did not see its way clear to sanction a provisional order, under which the Vestry can supply electrical energy. The Vestry resolved to refer the matter to the Electric Light and Dust Destructor Committee to consider the best method of approaching the Board of Trade again in relation to the subject.

Lowestoft.—In connection with the proposed combined electric lighting and destructor scheme, Mr. Hawtayne and the surveyor are to prepare a plan showing the position of the destructor. The Horsfall Furnace Syndicate is to submit drawings, estimate, &c., of a 4-cell Horsfall destructor and plant for clinker grinding.

Lynn.—The Electric Lighting Committee has received Prof. Robinson's report on electric lighting, and the Council will consider it in committee. There is to be opposition.

Maidenhead.—The Electric Lighting Committee is to engage a consulting engineer to prepare a scheme and report at a fee of 75 guineas.

Maidstone.—The Electric Lighting Committee has recommended the Council to consult Mr. Hawtayne, or some other expert, as to the best method of carrying out the provisional order.

Marylebone.—The Vestry last week resolved to proceed with the execution of the proposed electric lighting works as soon as possible after the grant of the necessary powers which are now being applied for.

Morecambe.—A Local Government Board inquiry was held on 9th inst. *re* application for a loan for £10,000 for the extension of the electric lighting works. The Clerk explained that with reference to the recent arbitration case with the old electric light company, the Council had been awarded as their share £1,179.

Newcastle.—At the last City Council meeting, when the question of street lighting arose, it was stated that the electric light companies had replied to inquiries that the price for the street lamps would be reduced if more lamps were used. It was further stated that the City Council pays £42 a year for each lamp, but if they had a larger number they could get them for £28 each. It was considered that if the Corporation put down municipal works they could have them for £14 each.

North Berwick.—The Town Council has appointed a committee to obtain information *re* electric lighting.

Perth.—The Sandeman Public Library is to be wired for electric lighting, but in the meantime no generating plant is to be put down.

Prestwich.—The District Council is to apply for a provisional order.

Sheffield.—The Sheffield Electric Light Company has given notice that after the end of the present month another 1d. will be taken off the price of the current, making it 4d. per Board of Trade unit.

The Corporation's common seal has been affixed to the agreement between the Electric Light Company and the Corporation respecting the transfer of the undertaking.

Spain.—A central station has just been completed and put in operation at Jadraque. Water power is utilised.

Sunderland.—A report has been submitted to the Electric Lighting Committee by the electrical engineer, showing that owing to the increasing demand, the station was becoming incapable of supplying all requirements. The present capacity was 745 electrical H.P. The committee will recommend the Council to apply to the Local Government Board for powers for further extensions. The amount asked for steam dynamos, switchboards, &c., will be £12,728; for the extension of feeders and mains to the Workhouse if required, £12,540; making a total of something like £26,000. It was decided to ask the Council for leave to borrow £10,000 for immediate requirements.

Taunton.—The new connections during February were equivalent to 512 8-C.P. lamps. The Mayor recently stated that whereas the expenses of the undertaking had only increased by £178 during the year, the profit realised had increased by £271 8s. 4d., and after paying all expenses they had a balance on the year's working of £43.

Torquay.—The Corporation electricity works were inaugurated yesterday afternoon.

Wallingford.—The Guardians have abandoned the idea of using electric light for the Workhouse. The annual cost (200 lights) of electric light was put at £264 16s., gas £199 4s., oil £165. Gas is to be used.

Walsall.—At the Town Council meeting on Monday, the Electric Lighting Committee reported that the number of consumers at the end of February was 104. They regretted to report that after paying interest on loans and providing sinking fund there was a deficiency of £531 17s. 7d. This, with the loss of £445 3s. 10d. on the previous year's working, made the total deficiency of the undertaking up to December 31st last £977 1s. 5d., and with a view to meeting the same the Finance Committee had been requested to include in the next rate estimate the sum of £400 in respect thereof. The report was adopted.

Wednesbury.—The Mayor was calling a special Council meeting for Wednesday last, to consider the question of providing electricity for the town.

West Ham.—The tenders for the wiring of public buildings for the electric light have been referred to the electrical engineer to report upon.

Weston-Super-Mare. — Messrs. Foote & Milne, of Victoria Street, London, have written to the District Council suggesting that they should transfer their electric lighting provisional order. The letter will lie on the table as the Council are intending carrying their order into effect.

Willesden.—The Electric Light Committee, after considering the report of the sub-committee appointed to inspect various electric lighting stations, has recommended that steps be taken to secure the services of an electrical engineer. The appointment will not take place until the new Council is elected.

Winchester.—It is expected that the electric lighting station will be completed in two or three month's time. The laying of mains has been commenced.

Withington.—The desirability of arranging terms with the Manchester Corporation for the supply of electric light to Withington, was considered by the District Council last week, and was to come up again at a special meeting to be held yesterday.

Woking.—The Surveyor reports that the Electric Light Company has promised to replace the old lamps in the streets with new.

Yarmouth.—Mr. A. W. Ranken, the Corporation electrical engineer has given in his resignation to take effect on May 31st. The Electric Light Committee has expressed appreciation of Mr. Ranken's valuable services. It is proposed to adopt the following scale of charges for electric motors: Per 1 horse-power motor, up to 100 units per quarter, 3½d. per unit; 100 units to 300 units, 3d.; 300 units to 500 units, 2½d.; over 500 units, 2d. Other size motors in proportion.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Aberdeen.—The Corporation Tramways Bill is being opposed by the House Proprietors' Association.

Alexandra Palace Electric Railway.—The new electric railway at the Alexandra Palace, arrangements for which have been progressing during the past three months, is now taking a practical form under the supervision of the consulting engineers, Messrs. Taylor & Field. The work is being carried out by the Imperial Electric and Power Company, who are working in conjunction with Messrs. Wandruszka & Co., of Berlin. The estimate of this, which was originally to be £6,000, has had to be materially increased to have a double line of rail, and the cost now will reach nearly £10,000. It is intended to run the electric cars with the overhead trolley system. Each car will seat 60 people, and will be about 40 feet long. They are *facsimiles* of the American pavilion car, and will be fitted with 70 horse-power motors. The fare will be 1d., either up or down the hill. This will be a great convenience to all visitors to the Palace travelling by the Great Northern Railway, the North London Railway, the South-Eastern Railway, and the London, Chatham and Dover Railway to Wood Green station, as well as to visitors going to the Palace Gate station on the Great Eastern, and, in fact, the whole of that enormous district including Hornsey, Wood Green and Tottenham.

Brighton "Underground."—In consequence of strong opposition on the part of the Brighton Corporation and other local interests, the Brighton Underground Railway Bill has been removed from the list of Bills which has been referred for consideration to the Committee of the House of Lords. The scheme has been referred to in these columns on several occasions.

Calcutta.—The directors of the Calcutta Tramways Company have laid before the Calcutta Corporations a lengthy communication dealing with their proposals in regard to electric traction.

Coventry.—The Stoke Parish Council has approved of the positions of the trolley poles of the Coventry electric tramways.

Dublin.—The Clontarf section of the electric tramways, which we have already described, was to be opened this week.

Electric Power Distribution.—A third time the Wolverhampton Town Council, at their monthly meeting on Monday, decided not to admit the Midland Electric Corporation Power Distribution, Limited, into the borough. At the meeting in question a letter was read from the Board of Trade regarding the provisional order sought by the Electric Corporation. The Town Council had refused to grant their permission to the company to enter Wolverhampton, and the company now asked that the consent might be dispensed with. The applicants, in their communication to the Board of Trade, submitted that the Corporations of Wolverhampton and Walsall and the Tipton District Council were not entitled to withhold their consent unreasonably, and that in this case they were doing so. Subsequently Councillor Leir Johnson moved that the Council rescind their previous resolution, and assent to the promotion of the provisional order. Alderman Jackson seconded the resolution, but after considerable discussion it was rejected.

Mr. J. F. Albright (chairman), Mr. G. L. Addenbrooke (engineer), and Mr. A. L. Lowe (secretary), of the Midland Electric Corporation for Power Distribution, Limited, were present last week at a special meeting of the Wednesbury Town Council held to discuss the scheme. It was resolved to consider the whole question at another special meeting of the Council in Committee. This was done on Monday evening, when, after a long discussion, it was decided that the Council should apply for a provisional order themselves in order to have the power of supplying electricity in their own hands.

On Monday, at the meeting of the Walsall Town Council, the Electric Lighting Committee reported that the Board of Trade had asked the Corporation to state their reasons why the Board should not dispense with the consent of the Corporation to the application by the Midland Electric Corporation for Power Distribution, Limited, and the town clerk has replied that the Council strongly object to the proposal of the company to supply electricity within the borough. The report of the Committee was adopted on the proposition of Councillor Brownhill.

The Tipton District Council has resolved to withdraw its opposition to the scheme provided the company will supply electricity for lighting in bulk to the Council at 2d. per unit, this to include the supply of mains.

Folkestone.—The Sandgate District Council has been informed that the Folkestone Electric Tramways Bill will not be proceeded with during the present session.

Hartlepool.—On Tuesday last week one of the guard wires broke in Northgate, but no one was injured.

Hastings.—Last week the Council, meeting in committee, passed resolutions favouring the placing of trams in the principal thoroughfares, excluding the Front Line and Robertson Street. The borough engineer is to bring up a report as to cost, line of route, and other details, and the Council will then probably apply for powers under the Light Railways Act.

Hendon and Finchley Light Electric Railway.—On Saturday last, at the Hampstead Vestry Hall, Mr. Fitzgerald and Colonel Boughey, Light Railway Commissioners, resumed an inquiry, opened on Friday at Hendon, into the scheme of the Hendon and Finchley Districts Light Railways Company. Mr. Vesey Knox, M.P., for the promoters, at the outset said that the line would serve what was practically a remote agricultural district, though within seven miles of Charing Cross. The line, which would be worked by electric traction with overhead wires, would start at Canfield Gardens, Hampstead, opposite the Metropolitan Railway station, following the main road to Church End, Finchley, while another ran through Hendon to the Hendon station of the Midland Railway. It was seven miles three furlongs long, a little over a mile of this being in the parish of Hampstead and County of London, seven furlongs in the parish of Finchley, and the rest in Hendon. Many of the people who lived in that part of this district, which was within six miles of Charing Cross, were two miles from the nearest railway stations. The service from Finchley to Hampstead would be one car in 15 minutes, and from Hendon one in 10, making a service of one car in six minutes through Hampstead. Evidence in support of the scheme was given by Sir Douglas Fox and Mr. Wragg, the engineers, Mr. J. T. Firbank, M.P., and Mr. W. M. Murphy, the promoters, Mr. Hearne, chairman of the Hendon District Council, and others. There was opposition from the Hampstead Vestry, the L.C.C., and the Middlesex County Council. The inquiry was adjourned.

Leith.—It is stated that a hitch has occurred in connection with the purchase of the tramway undertaking in Leith. The lessees are described in the draft lease as Messrs. Dick, Kerr & Co., and the Edinburgh and District Tramway Company. It has been discovered that the Edinburgh and District Tramway Company are not licensed lessees, not having got sanction from the Board of Trade. Until this matter is rectified, negotiations for the purchase in Leith will be practically at a standstill.

Norwich.—In the House of Commons on Monday night the Norwich Electric Tramways Bill was read a second time and committed.

Orme's Head.—The Llandudno Council, and the promoters of the Orme's Head Tramway, have agreed upon terms whereby the Council shall have the option of purchase in 28 years, on a return at the rate of 4½ per cent. on total capital invested in the undertaking.

Paisley.—The Paisley Tramways Company recently entered into an agreement with the British Electric Traction Company for taking over the tramways and working them electrically. The British Electric Traction Company has now laid a comprehensive proposal before the Town Council regarding the scheme. Conditional on the Council granting the company a lease of the streets of the burgh for a period of 28 years, it will undertake to put down and work an overhead trolley system, to extend from Paisley Cross westward to Johnstone, southward to Potterhill, northward to Renfrew, and eastward to join with the outlying extremity of the Glasgow tramways. A Committee of the Council has instructed Mr. Teague, electrical engineer to the Corporation, to make inquiries at towns which have adopted the trolley system, and report to the Council in committee. Should the Town Council accede to the agreement, Parliamentary sanction would require to be obtained, and power will be asked to acquire property in narrow streets through which the tramways may run.

The Proposed City and Brixton Electric Railway.—The engineers have prepared, for the information of Parliament, detailed estimates of the cost of carrying out this scheme. The proposed line, which will run from a junction with the City and South London Railway, under the High Street, Borough, to Brixton Hill, is estimated to cost in the aggregate £818,040, of which the railway will cost £786,415, the cost of widening the City and South London Railway, in order to accommodate the traffic, £24,725, and the proposed subway to the Oval station of the City and South London Railway £6,900. The line will be three miles five furlongs in length, and will be constructed in every respect similar to the City and South London Railway, which it is proposed to purchase from the point where the new line will join it to its termination in King William Street. The capital of the company is proposed, says the *Financial Press*, to be fixed at £1,200,000, with the right to raise a further £400,000 by the issue of debenture stock. The engineers will be Sir Benjamin Baker, Mr. David Hay, and Mr. B. Mott. It is stated that the prospectus of this company will shortly be before the public under the title of the City and Brixton Electric Railway Company.

Yarmouth.—The solicitors to the Yarmouth and Gorleston Tramways Company have written to the Town Council as follows:—"Under the Yarmouth and Gorleston Tramways Extension Provisional Order Confirmation Act, 1897, the company, as you are aware, are empowered to construct the extension of their line thereby authorised, and to work the entire traffic by electrical power. With a view to give the greatly improved service which this modern method of traction would permit, the company are prepared to carry out the powers of the Act at an early date; but as there does not appear at present any probability of the necessary current supplied by the Council on the west side of the river, it seems that the company themselves will have to provide it, and in that case the company would be willing to erect a generating station, capable of supplying not only the requisite power for working their tramway, but, also to provide current for lighting purposes on that side of the river, should the Council desire them to do so, on terms to be agreed." The company proposes to employ the overhead trolley, and suggests a meeting with the Council to explain the proposals fully. The Electric Light Committee has asked the Company to submit written particulars of the proposals.

TELEGRAPH AND TELEPHONE NOTES.

The African Trans-Continental Telegraphs.—A Reuter despatch says that the *British Central Africa Gazette* reports that telegraphic communication between Zomba and Kota Kota was opened on December 10th. The actual construction of the line is now 60 miles north of Kota Kota, and holes have been dug 84 miles beyond that place. As Kota Kota was practically only opened up to European occupation on the death of the late Jumbe in 1894, it will be seen what great progress the country has made during the last three years. There is some idea of constructing a branch line from Kota Kota to Fort Alston. In view of the present troubles in northern Rhodesia, this would be of immense advantage. The telegraph staff at Blantyre has set up a telephone system there, and it is stated that a connection will shortly be made with Zomba. Towards the end of December there was an interruption on the telegraph line between Zomba and Fort Johnston. Mr. Kennedy, who went out to effect repairs, found that the breakdown was due to the fact that a native had built his hut directly under the wire, and when the hut accidently caught fire, the wire was softened and broke with the strain. The Acting Commissioner has now issued instructions to all the districts through which the line passes that natives should be advised not to build their huts within at least 10 yards of the telegraph track. The natives of Central Africa occasionally use the telegraph to send messages to each other in their own language.

Canada-Australia Proposed Cable.—In the House of Commons last Monday Mr. R. G. Webster asked the Secretary of State for the Colonies whether any further steps had been taken in regard to establishing a direct cable communication betwixt the Dominion of Canada and Australia, and if any papers would be laid upon the table on that subject. Mr. Chamberlain, in reply, said that the question was still under consideration, and no papers could then be laid.

Delays in Australian Telegrams.—In the Australian papers of last month, just to hand, we learn that on February 2nd, the following official message was received from Adelaide:—"Port Darwin line interrupted between Oduadatta and Charlotte Waters. Line between Perth and Roebuck Bay working badly, and little prospect getting business that way." In consideration of the fact, which we have frequently pointed out, that there are only the two lines above referred to by which telegrams to Europe can be transmitted, the "prospect" of getting business through at all is none of the brightest.

Pacific Cable.—The Committee of the British Empire League, sitting at Ottawa on 11th inst., discussed the Pacific cable question, and a proposal was made for the creation of a trust under the authority of the several Governments concerned, with power to raise funds to establish and operate the line.

South American Cable Taxes.—According to the *Financial News* there seems to have been considerable discontent in the mercantile community in Brazil at the heavy tax which is placed by the Argentine Government on telegrams in transit from Brazil, *viâ* Buenos Ayres, to the west coast of South America. It has now been strongly urged upon the Brazilian Government that some retaliatory measures should be adopted, such as the placing of a heavy tax upon telegrams to or from the Argentine Republic. There is, of course, another way of meeting the difficulty—namely, the establishment of direct telegraphic communication across the continent from Rio de Janeiro to the west coast, without the detour through the Argentine Republic. But this is obviously an expensive expedient, and the other is being more strongly pressed upon the Brazilian Government.

The Telegraph Wire Export Trade.—February proved to be a fairly active month in the export trade of this country in telegraph wire and apparatus connected therewith. The exports for the month reached a total value of £75,276, as compared with only £37,923 in January last, and only £43,710 in the corresponding month of 1897. So far as the year has gone it shows a slight improvement over last year, but is still much below the activity recorded in the early months of 1896, the respective figures for the two months being, 1898, £113,205; 1897, £105,830, and 1896, £167,064.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1898 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Paramaribo-Cayenne ...	Jan. 27th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Obidos ...	March 9th, 1898. ...	...
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Aden-Zanzibar	Feb. 28th, 1898 ...	March 4th, 1898.
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Majunga-Tananarive ...	Feb. 28th, 1898 ...	March 6th, 1898.
" " ...	March 15th, 1898 ...	...
Saigon-Bangkok	" 2nd, 1898 ...	March 3rd, 1898.
" "	" 7th, 1898 ...	" 7th, 1898.
" "	" 9th, 1898 ...	" 12th, 1898.
" "	" 12th, 1898 ...	" 13th, 1898.
" "	" 14th, 1898 ...	" 15th, 1898.
" "	" 15th, 1898 ...	...
Bolinao-Manila-Laminos ...	" 9th, 1898 ...	...
Indo-European line ...	" 10th, 1898 ...	March 11th, 1898.

The Telephone Service.—It is announced that at the annual meeting of the Association of Municipal Corporations to be held at the Guildhall on Saturday, 26th inst., the City Solicitor will move: "That it is undesirable that the jurisdiction of local authorities over telephone companies should be curtailed or interfered with by the undue exercise by Her Majesty's Postmaster-General of his rights or privileges under the Telegraph Acts; and that a representation to this effect be made to Her Majesty's Government."

The Portsmouth Chamber of Commerce is persuading its local Members of Parliament to support the movement in the House of Commons to upset the present arrangement between the National Company and the Post Office.

The London County Council has before it a report of the Highways Committee with reference to the National Telephone

Company's underground works. During last year the Council consented, subject to certain conditions, to the placing underground of the company's system in connection with 14 exchange stations. These conditions were to be embodied in an agreement, but the Highways Committee, having given careful consideration to the draft agreement, have come to the conclusion that additional conditions ought now to be inserted to provide – (1) that the company should pay a rent in consideration of its user of the public streets, and (2) that the present charges to subscribers should be reduced to amounts which in the opinion of the Council's engineer would, in the event of the Council establishing an independent telephone service for London, amply repay expenses and, as the system was extended, might possibly be reduced by 15 or 20 per cent. A draft agreement embodying these provisions has been submitted to the company, who in a letter to the Council have pointed out that, with reference to the first proposal, the company has to obtain the consent not only of the Council, but of the road authority, which latter may impose conditions, and that the company cannot be expected to make payments both to the Council and to the road authorities in respect of wayleaves under the streets, and, further, that such requirements are inconsistent with the demand for a cheaper telephone service. As regards the second proposal the company declines to discuss it, but is prepared to consent, as it has done in the case of some provincial towns and cities, not to increase the present tariff of charges. The Highways Committee think there is some force in the company's representation with reference to the possible effect of the first proposal, and they state they have reluctantly decided, should the Council approve, not to press for the clause to be inserted in the agreement. As regards the second point, they are of opinion that it is advisable in the interests of the inhabitants of London that the principle should be insisted upon. They will accordingly ask the Council to insist on the retention of this clause in the agreement. The schedule attached to the clause sets out the tariff proposed by the Council. The charges are to be—on a five years' agreement, for first connection £12 a year, second and additional connections £10, and private houses £8 a year; on a yearly agreement, first connection £15 a year, second and additional connections £12-£10, and private houses £10 a year. These tariffs are to apply to an area of 609 square miles, which comprises the towns of Dartford, Redhill, Croydon, Epsom, Richmond and Kingston on the south of the Thames; and Tilbury, Woodford, Romford, Epping, West Ham, Harrow, Ealing and Hampton Court on the north.

The Bootle Town Council will support the proposals of the New Mutual Telephone Company.

The Brierley Hill and Colwyn Bay District Council also support the company's proposals.

Western and Brazilian Telegraph.—*Money* says that some idea of a possibly impending arrangement between the Western and Brazilian Telegraph and the Direct West India Cable Company was mooted in the market last week, with the result that Western and Brazilian ordinary shares have been put up.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—March 30th. Tenders are being invited by the municipal authorities of Ghent for the supply and erection, &c., of a complete installation for the electric lighting of the town dock. Particulars may be obtained from, and tenders to be sent to, l'Hotel de Ville, Ghent, Belgium.

Belgium.—April 1st. The Municipal Authorities of Seraing are inviting tenders for the concession for the supply of electrical energy in the town for public and private lighting purposes during a period of 30 years. Particulars may be had from, and tenders to be sent to, the College des Bourgmestre et Echevins, Seraing, Belgium.

Blackpool.—March 22nd. The Corporation wants tenders for a tubular boiler, superheaters, condensers, rectifiers, boosters, transformers, lead-covered cables, arc lamps and pillars. Borough electrical engineer, Mr. R. C. Quin. See our "Official Notices" February 25th.

Bournemouth.—The Corporation wants tenders for the electric lighting of the pier and pleasure grounds. Particulars *re* plant, &c., are given in our "Official Notices" this week. Borough engineer, Mr. F. W. Lacey.

Bournemouth.—April 4th. The Corporation wants tenders for motor vehicles for the collection of house refuse, &c. Borough engineer, Mr. F. W. Lacey. See our "Official Notices" this week.

Darwen.—March 28th. The Corporation wants tenders for the supply of steam engine and dynamos, piping, accumulators, switchboards, mains, arc lamps, pillars, &c. See our "Official Notices" March 11th.

Derby.—March 24th. The Corporation wants tenders for the electric wiring of the Lunatic Asylum and premises at Rowditch. See our "Official Notices" March 4th.

Derby.—April 12th. The Corporation wants tenders for the electric wiring of its Ford Street yard and premises. See our "Official Notices" this week.

Devizes.—March 21st. Tenders are wanted for the supply and delivery of two 40-kw. continuous current belt-driven dynamos for the Wilts County Asylum, Devizes. Engineers, Messrs. Massey & Allpress, 25, Queen Anne's Gate, Westminster. See our "Official Notices" March 4th.

Edinburgh.—March 22nd. The Council wants tenders for the additions and extensions to the electric lighting at the City Chambers. See our "Official Notices" March 11th, for particulars.

France.—March 30th. Tenders are being invited by the municipal authorities of Paris for the supply of the electrical conductors, required in connection with the electric lighting of the Square Vaugirard. Particulars may be had on application, and tenders to be sent, to l'Hotel de Ville, Paris.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

Hampstead.—March 31st. The Vestry wants tenders for the supply and erection of one or two steam alternators, switchboard panels, two induced draught wet back boilers, feed water heater, steam and exhaust pipes, feed pumps, 50 kw. exciter, and a feed water softener. See our "Official Notices" this week for full particulars.

Leyton.—April 4th. The District Council wants tenders for the supply of two dynamos, one transformer, two gas engines and connections, and switchboards for extension of the electricity works. Electrical engineer, Mr. H. C. Bishop. See our "Official Notices."

Plymouth.—March 23rd. The Corporation wants tenders for the supply of alternating current meters for the year ending March 31st, 1899. Particulars from Mr. J. H. Rider, Borough electrical engineer, East Street, Plymouth.

Spain.—March 21st. The Municipal Authorities of Santona (province of Santander) are inviting tenders for the concession for the electric lighting of the public streets of the town during a period of 20 years. Tenders to be sent to El Secretario del Ayuntamiento de Santona (Santander) from whence full particulars may be obtained.

Spain.—March 29th. Tenders are being invited by the municipal authorities of the town of Zafra (Badajoz province) for the concession for the electric lighting of the public streets during a period of 20 years. Particulars and conditions may be obtained from, and tenders to be sent to, El Secretario del Ayuntamiento de Zafra (Badajoz), Spain.

Switzerland.—April 30th. Plans and estimates are being invited, says the *Contract Recorder*, by the Government authorities of Fribourg, Switzerland, until April 30th next, for a projected electricity generating station to be established at Hauterine. Water-power is to be utilised, and the station will have a capacity of about 6,000 H.P. A premium of £120 will be awarded to the three schemes submitted which are considered to be the best. Plans and estimates are to be sent to the Department des Travaux Publics, Fribourg, Switzerland, from whence full particulars of the competition may be obtained.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—March 21st. The Telegraph Department of the Victorian Government Railways is inviting tenders for the supply of alternating current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer Street, Melbourne.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

CLOSED.

London, E.C.—The Court of Common Council has accepted the tender of Messrs. Ashwell and Nesbit for £145 9s. for installing the electric light in certain rooms in the Guildhall Library.

Newport.—The Council has accepted the tender of Messrs. W. T. Glover & Co. for £4,288 12s. 4d. for cables and underground work required for the extension of the electric lighting of the borough. The tender of the Electric Construction Company, Limited, at £661 for transformers, and that of Messrs. G. Smith and Co., Limited, Glasgow, for 30 arc lamps at £325 have also been accepted.

Portsmouth.—Mr. T. W. Quick's tender for the extension of the electric light station at £4,198 has been accepted by the Council. Other tenders have also been accepted for additional plant, including boilers, feed pumps, &c.

FORTHCOMING EVENTS.

1898.

Friday, March 18th.—State visit to the Northampton Institute for the purpose of inspecting it and formally declaring it open.

Saturday, March 19th.—E. E. Students' visit to the works of Messrs. Easton, Anderson and Goolden, Limited, Erith.

Monday, March 21st, at 8 p.m.—Society of Arts. Prof. W. Noel Hartley, F.R.S, on the "Thermo-Chemistry of the Bessemer Process," Lecture II. (Lecture III., March 28th.)

Yorkshire College Engineering Society. Annual general meeting.

Devizes electrical plant tenders. (Wilts County Asylum.)

Tuesday, March 22nd.—Blackpool Corporation electrical plant tenders.

Edinburgh electric lighting extensions tenders.

At 8 p.m.—The Institution of Civil Engineers (ordinary meeting). Further discussion on "Calcium Carbide and Acetylene," by Henry Fowler, Assoc.M.Inst.C.E.

Wednesday, March 23rd.—Plymouth Corporation electric meter tenders.

Thursday, March 24th, at 8 p.m.—The Institution of Electrical Engineers. "Cost of Generation and Distribution of Electrical Energy," by R. Hammond, member.

At 3 p.m. — Royal Institution. Prof. J. A. Fleming's fourth lecture, "Recent Researches in Magnetism and Dia-magnetism." (Lecture V., March 31st.)

Derby Asylum wiring tenders.

Friday, March 25th, at 8 p.m.—The Institution of Civil Engineers (students' meeting). "Internal Governor Friction," by H. O. Eurich, Stud.Inst.C.E.

At 5 p.m.—Physical Society at the rooms of the Chemical Society, Burlington House. (1) "On the Circulation of the Residual Gaseous Matter in a Crookes Tube," by Mr. A. A. Campbell Swinton. (2) "On some Improvements in the Roberts Austin Recording Pyrometer, and Notes on Thermo-electric Pyrometers," by Mr. A. Stansfield.

At 8 p.m.—Electro-Harmonic Society. Smoking Concert at St. James's Hall Restaurant.

Wednesday, March 30th, at 8 p.m.—Society of Arts. Prof S. P. Thompson, on "Telegraphy Across Space." Mr. J. W. Swan, F.R.S., will preside.

Royal United Service Institution. Captain J. N. C. Kennedy on "Wireless Telegraphy."

NOTES.

Obituary.—Our readers will have heard with regret of the death of Sir Henry Bessemer, which occurred on Tuesday evening at his residence at Denmark Hill. Sir Henry was in his 86th year, he being born at Charlton, Hertfordshire, in 1813. His name will ever be remembered in connection with his process for the conversion of cast-iron into cheap steel, and the great difficulties he encountered in introducing his process are well-known matters of history. Wednesday's *Times* contains an interesting two-column notice of Sir Henry's life. The first recognition of Bessemer's work came from the Institution of Civil Engineers, in the shape of the gold Telford medal in 1859. In 1871—73 he was president of the Iron and Steel Institute, and founded a gold medal to be given annually for the most important improvement of the year in the manufacture of iron or steel. The Society of Arts awarded him the Albert gold medal in 1872, and in 1877 the Civil Engineers made him a member of their body, at the same time presenting him with the first Howard quinquennial prize. Two years later he became a Fellow of the Royal Society, and received the honour of knighthood, while in 1880 he was presented with the freedom of the City of London. From abroad he received many honours. He was offered the Grand Cross of the Legion of Honour, but, as permission to wear it was refused, he had to be content with a large gold medal given him by Napoleon III. He was an honorary member of the Iron and Steel Board of Sweden, a freeman of the City of Hamburg, an honorary member and gold medalist of the Society of Arts and Manufacturers of Berlin, and a Grand Cross of the Order of H.I.M. Francis Joseph of Austria. It will be remembered that Lady Bessemer died last year.

Mr. Main, a native of Aberdeen, whose untimely end we announced in our last issue, was best known to the electrical world as the inventor of the arc lamp known as the Fyfe-Main. This lamp he patented in 1881 in conjunction with Mr. A. L. Fyfe, and it appeared about the time when the early fever for electric lighting was at its height. A sum was offered for the patent which would have been a small fortune for the owners, but, unfortunately, a hitch occurred in the negotiations, the opportunity passed, and Mr. Main never received anything for his valuable invention, except the ordinary manufacturers' profits for the lamps he made in his own small workshop. For the 17 years preceding the invention of the Jablochkoff candle, the Serrin lamp was the only lamp capable of giving a decently steady arc light, but its mechanism was too complicated, and its working not quite steady enough for public lighting. Mr. Main unconsciously designed his lamp on the same general principles as the Serrin, but he immensely simplified the mechanism by lifting the feeding train bodily when the arc was made, and thereby doing away with the parallel motion in the Serrin. The Fyfe-Main lamp is in use for lighting the leading newspaper offices in London, including the *Daily Telegraph*, *Standard*, and *Daily News*, and also in the brilliant example of street lighting at Electric Avenue, Brixton. Anyone who has seen this lamp will admit that it is one of the steadiest and most reliable lamps in use. Mr. Main combined great inventive and mechanical skill with a sort of intuitive knowledge of the principles underlying his mechanical creations. He was the ideal man for the inventor with an idea and an insufficiency of mechanical skill to translate his idea into practice, and many well known men have owed much of their success to his valuable assistance. One of Mr. Main's recent patents is a revolving gas lamp for advertising and show purposes. The large glass case surrounding the gas jets is slowly revolved by the action of the heated air upon a light fan or turbine mounted in the frame above the gas jets. Simple as this problem may seem, it appears to have never been practically solved till Mr. Main, after much trial and many failures, made it a complete practical success. Mr. Main's estimate of his own abilities was too modest to allow him to advertise himself, but his sterling qualities were known and appreciated by his intimate friends.

The International Ohm.—The *Elektrotechnische Zeitschrift* states that in view of the impending publication of the Bill concerning electrical units of measurement, the German Imperial Post Office authorities have resolved to introduce the ohm in place of the Siemens unit. In future all new apparatus and measuring instruments will be standardised in ohms. Existing curved handled rheostats and resistances used in connection therewith will at once be regauged, whilst other apparatus and instruments will be similarly dealt with on being sent to the workshops for repairs as occasion may arise. Statements of resistances in official reports will in future always be expressed in ohms.

Mean Horizontal Candle-Power.—The mean horizontal candle-power of an incandescent lamp is usually taken as the measure of the light emitted. This, says New York *Electricity*, is perhaps the best measurement to take, but with certain of the new types of filaments will have to be replaced by the mean spherical candle-power. The mean horizontal candle-power can be obtained either by the laborious method of taking a large number of readings at different angles, or by spinning the lamp so as to obtain optically the mean candle-power. There have been doubts, though, on this spinning process as to whether it will give accurate results. Deformation of the filament, due to centrifugal force, would be the most likely cause of error, if any. Mr. C. P. Matthews contributes an article on this subject to a recent number of the *Physical Review*. His experiments were carried out at the Purdue University, and show conclusively that no such error exists. Thus the whirling lamp gave a mean horizontal candle-power of 9·649, while the figures obtained by plotting the series of readings for different angles and integrating the curve was 9·655 C.P. This shows an error of ·06 per cent. only, which is very well within the limits of photometric accuracy.

Electrical Energy (Generating Stations and Supply).—In the House of Commons on Thursday last week, the Earl of Morley moved:—"That it is desirable that a Select Committee be appointed to join with a committee of the House of Commons to consider and report—1. Whether, notwithstanding the provisions of Section 12 (1) of the Electric Lighting Act, 1882, powers should be given in any cases for acquiring land compulsorily for generating stations; and, if so, under what conditions as respects liability for nuisance, notices to surrounding owners, and otherwise. 2. Whether compulsory powers of acquiring land for generating stations, if proper to be given in any case, should be given where the proposed site is not within the area of supply. 3. Whether, in case of a generating station, however acquired, not being situate within the area of supply, power should be given for the breaking up of streets between the generating station and the boundary of the area of supply. 4. Whether powers should be given in any case for the supply of electrical energy over an area including districts of numerous local authorities, involving plant of exceptional dimensions and high voltage; and, if such powers may properly be given, whether any, and what, conditions should be imposed—(*a*) With respect to system and plant, and to the construction and location of generating stations, in view of the powers of purchase conferred upon local authorities by Sections 2 and 3 of the Electric Lighting Act, 1888; (*b*) with respect to the relations of the promoters to other undertakers, and to local authorities within parts of the area. 5. Under what conditions (if any) ought powers to be conferred upon promoters seeking to supply electrical energy to other undertakers and not directly to consumers." The motion was agreed to.

The House of Commons had the matter brought before it on Monday, and concurred in the House of Lords' resolution referring the question to a Joint Committee of both Houses. On Tuesday the House of Lords appointed the following peers to represent the House on the Joint Committee:—Lord Cross, Lord Spencer, Lord Knutsford and Lord Monkswell.

Engineers' Strike.—With reference to the statement in our last issue that the Employers' Federation had returned Messrs. Tangye's cheque for £500, Sir Richard Tangye writes a long letter to the *Standard*, remarking that the statement is wholly misleading, and setting forth the facts of the case. We extract the following from his letter:—

> . . . . At the end of January last we were urgently invited to contribute to the Engineer Employers' Special Fund, on the ground of the heavy strain which had been imposed upon the employers in the recent struggle. On February 10th my company contributed the sum of £500 to the fund. . . . So far from being "at once" returned, the cheque was cashed and paid into the fund, and an acknowledgment sent us by the Federation . . . . . under date February 11th. . . . .
>
> On February 28th—*i.e.*, 17 days after this acknowledgment—Mr. Biggart, the secretary, sent us a banker's draft for £500, with a letter, in which he says: "We have now had an opportunity of reporting your contribution of £500 to our Committee. This is the first meeting held since your cheque was received." He goes on to say his first letter was sent *per incuriam*, but as it contained the distinct statement that he had been desired by his committee to thank us, the explanation of this extraordinary discrepancy must be left to that gentleman. I should explain that long before we gave our contribution to the Federation it was well known to every member of that body that we were not in sympathy with their policy. This fact we expressly stated at an early period of the struggle, and again laid stress upon when handing over our cheque. It was, therefore, with this knowledge that the Federation accepted and thanked us for the gift we had been invited to make. With their reasons for subsequently reversing their own action I am not concerned. . . . .

Manchester Explosion.—At 9 p.m. on 9th inst., an explosion occurred in the roadway at the junction of Withy Grove and Corporation Street, Manchester. A portion of the footpath was blown up, some of the flags being sent through a shop window. We understand that the explosion was due to the ignition of an explosive mixture of coal gas in one of the Corporation electric light junction boxes, and a 6-inch pipe communicating therewith. The mixture was fired, as far as can be ascertained, by a spark due to the failure of some rubber cables in the pipe about 200 yards away. No person was hurt, but several panes of glass were broken.

Institution of Junior Engineers' Conversazione.—The conversazione of the Institution of Junior Engineers was held on Saturday last, 12th inst., at the Westminster Palace Hotel. The gathering was opened by a reception in the large hall by the president (Mr. Aspinall), and Mrs. Aspinall, and the chairman (Mr. H. Bloomfield Vorley) and Mrs. Vorley. An excellent programme of music was executed in the large hall by Mr. W. M. Day's band, and in the music room, the Poppy Pierrot troupe rendered a selection of vocal pieces. Among the numerous items with which the company was entertained, were demonstrations by Mr. Leslie Miller, on signalling without wires, and some instructive and pleasing lecturettes on the Maxim gun by Mr. Hiram S. Maxim. Messrs. J. Thornycroft & Co. showed in operation, during the evening, a model Thornycroft water tube boiler; Messrs. Thorn & Hoddle showed acetylene gas apparatus, including "Incanto" generators; Mr. R. J. Wallis-Jones (Electric Welding Company) exhibited specimens of electric welding work; and Mr. Arthur Rigg showed the variable-stroke hydraulic engine, of which he is the inventor. Mr. J. A. Prestwich's cinematograph displays were, of course, well received, and good use was made of the electrophone room, where, through the courtesy of the Electrophone Company and the National Telephone Company, 16 instruments connected to the various theatres were available. There were also a large number of exhibits in the various halls, and we select for mention models and photographs of a Babcock & Wilcox land boiler; models of Great Eastern Railway locomotive boiler, and parts, liquid fuel injector, express engine, paddle steamer, &c., by Mr. James Holden; photographs of Lancashire and Yorkshire Railway, from the president; Maxim guns, projectiles, &c., from Mr. Maxim; stereoscopic figures of spherical catenaries, &c., shown by Prof. A. G. Greenhill (vice-president) and Mr. T. J. Dewar; also sections, drawings, &c., of the Westinghouse electro-pneumatic signalling apparatus, lent by the Westinghouse Brake Company. A large number of members and friends were present, and an enjoyable evening was spent.

Accumulator Testing.—The following reached us too late for insertion in our "Correspondence" columns:—"In reference to 'Appak's' remarks, your correspondent desires to say that 'Appak' has not comprehended the meaning of the remarks about calculating weight of cells from results of tests on one positive. It is quite easy and accurate to calculate the weight of a 17-plate cell, given the weight of plates and capacity of a 3-plate cell. And also knowing that cells increase in capacity per pound as the plates increase in number up to a certain limit, as shown by an interesting curve in Electrical Review of December 10th, 1897. 'Appak' may not be able to make these calculations, but your correspondent can, and so can many others. The little experiment with eight plates suggested by 'Appak' is an ancient one, and only proves what is well known, *i.e.*, a 3-plate cell has about half the capacity per pound that a 5-plate has—a fact which does not at all prove that by taking the results of a test on a 3-plate cell we cannot calculate what would be the capacity per pound of the 5-plate cell.—Your Correspondent."

The Electric Cab Mishap.—With reference to the reported burning of an electric cab at Westminster, regarding which the daily press, as usual, made such sensational statements, we learn from Mr. Bersey, of the London Electrical Cab Company, that the cab in question was the one which has been running for the *Daily Graphic* for six months, and during the whole of that time has only stopped one day in order to have fresh rubber tyres put on. What happened on Tuesday was, that the insulation on the wires running under the body between the motor and the controlling switch got rubbed off, and consequently caused a short circuit, and some sparking between the wires. This went on for some little time, until it affected some of the lead connections on the cells, causing them to fuse and melt. Immediately this happened, of course everything stopped, as there was no longer a connection between the cells. There was no question of burning, or the cab being on fire whatever. We understand that the cab was running again on Tuesday night after a delay of only a few hours.

Buckingham Palace Lighting.—In the Civil Service estimates for the coming year, under the heading of Royal Palaces, there is an item of £3,500 for beginning the installation of the electric light at Buckingham Palace.

Lectures.—Mr. George Balfour, A.I.E.E., delivered an illustrated lecture on "Electric Tramways and Railways," in the Gilfillan Hall, Dundee, on 11th inst. A number of town councillors were present, and the Lord Provost presided.

Mr. J. E. Lloyd Barnes, M.I.M.E., was to lecture on Wednesday at the Town Hall, Birkenhead, on "Electric Traction."

On 8th inst. the Right Rev. Monsignor Molloy lectured at the new theatre of the Leinster Hall, Dublin, on "Wireless Telegraphy."

Pacific Cable.—Reuter says that the New Zealand Government regards as premature the proposal of the Eastern Telegraph Company in the matter of the guarantee, and favours the Pacific cable scheme.

Forthcoming Marriage.—A marriage has been arranged, and will shortly take place, between Mr. J. G. Butcher, Q.C., M.P., and Mrs. J. E. H. Gordon, widow of the late Mr. J. E. H. Gordon, who was so well known to the electrical fraternity all over the world.

NEW COMPANY REGISTERED.

British Automotive Proprietary Syndicate, Limited (56,357).—Registered March 4th with capital £55,000 in £1 shares, to adopt an agreement with Automotive Syndicate, Limited, and to manufacture, sell, and deal in electric, steam, gas, oil, and other motors and engines. The subscribers (with one share each) are:—T. E. Garlick, 17, Basinghall Street, E.C., chartered accountant; M. Warren, 17, Basinghall Street, E.C., clerk; W. P. Westell, St. Albans, clerk; J. Lewis, 17, Basinghall Street, E.C., clerk; J. M. Lewers, 17, Basinghall Street, E.C., clerk; C. E. Darling, Longdon Hall, Rugeley, clerk; G. Taylor, 60, Dyne Road, Brendesbury, clerk. The number of directors is not to be less than three, nor more than seven. The subscribers are to appoint the first. Qualification, £100; remuneration, £100 each per annum (£150 for chairman), and a percentage of the profits. Registered by Marshall & Marshall, 3, Lincoln's Inn Fields, W.C.

CITY NOTES.

Notting Hill Electric Lighting Company.

Probably no company in London engaged in the electric lighting business has shown better progress than the Notting Hill Company. For the year 1894 a microscopical dividend of 2s. per share was paid on each £10 share; in 1895 this had advanced to 2 per cent; last year 4 per cent. was returned to the ordinary shareholders, and for the year 1897 a handsome dividend of 6 per cent. has been declared. The success of this company is all the more noteworthy, because it was generally held that the district in which its operations were confined was one of the least favourable in London for an electric lighting concern.

The following shows the increase in the various accounts for the past year:—

Increase.

Capital expenditure.	Output in units.	Working expenses.	Revenue from sale of current.
£14,079	124,182	£1,016	£2,864

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£113,184	£99,105
Number of units sold	354,969	230,787
Number of lamps connected	—	25,718
Revenue from sale of current	£10,230	£7,366
Net revenue	£6,854	£4,736
Average price obtained per unit ...	6·9d.	7·59d.

Cost of Production.	£	Per unit.	1896.
Coal	982	·66d.	·71d.
Oil, waste, water, and engine room stores	138	·09d.	·18d.
Salaries and wages at generating station	485	·33d.	·43d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	648 (Works' cost 1·52d.)	·44d.	·47d.
Rent, rates and taxes	129	·09d.	—
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	1,976	1·34d.	1·69d.
Depreciation of buildings and plant account	—	—	—
Renewal fund account	—	—	—
Total	£4,358	2·95d.	3·48d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	10,230	0	0	6·9d.
Meter rents, &c.	519	0	0	—
Supply of steam	—			—
Transfer fees	36	0	0	—
Total	£10,785	0	0	6·9d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·95d.; works' cost, 1·52d.

St. James's and Pall Mall Electric Lighting Company.

The principal features of the year's work are already familiar to our readers, but a closer examination of the accounts reveals one or two interesting points. The capital expenditure has been increased by a little over £12,000, but the output has advanced from 2,401,431 to 3,028,242 units—an increase of 626,811. The items in the cost of production are, perhaps, not quite as pleasing as last year, though the total cost is slightly less. Repairs and maintenance, during the year have been exceptional, and stand at £5,104, against £2,886 for 1896.

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£254,077	£241,328
Number of units sold	3,028,242	2,401,431
Number of lamps connected	126,827	108,803
Revenue from sale of current	£66,376	£53,967
Net revenue	£30,534	£25,339
Average price obtained per unit	5·26d.	5·39d.

Cost of production.	£	Per unit.	1896.
Coal	6,514	·52d.	·50d.
Oil, waste, water and engine room stores	922	·07d.	·08d.
Salaries and wages at generating station	5,324	·42d.	·47d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	5,104 (Works' cost 1·41d.)	·40d.	·29d.
Rent, Rates and taxes	2,573	·20d.	·22d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	7,400	·59d.	·67d.
Depreciation of buildings and plant account	—	—	—
Renewal fund account	—	—	—
Total	£27,837	2·20d.	2·23d.

Not included in above.

Depreciation on plant, buildings, &c.	£9,270
Miscellaneous expenses	112

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	66,376	0	0	5·26d.
Meter rents, &c.	1,529	0	0	—
Supply of steam	80	0	0	—
Other items	155	0	0	—
Total	£68,140	0	0	5·26d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·20d.; works' cost, 1·41d.

Development of Electric Lighting in London.

We give the following from the *Daily Mail* for what it is worth:—The St. James's and Westminster Electric Lighting Companies are asking for powers this session to build a joint station on some land near North Bank, St. John's Wood. It belongs to the Great Central Railway, and the idea of the companies is to relieve the stations at Carnaby Street and Davies Street. It is understood that the sole object of the acquisition is to assist the purposes of the joint companies, and not for competition with other electric light concerns, a rumour to which effect has been of late current. In two years' time both the other stations would be overloaded, and by then the new station is expected to be ready. We should not, however, be surprised to find that an assault was intended upon one of the electric lighting companies, which has hitherto endeavoured to have things very much its own way.

Kensington and Knightsbridge Electric Lighting Company.

The report for the year shows steady and substantial progress. The chairman of the company at the annual meeting referred to a feature in the development of the company's business that appears to us a most encouraging one. There had been an increase in the number of consumers over that of the previous year, although the total increase of lamps was not as large as in the year 1896. This seems to indicate that electric lighting is extending among the less wealthy class of customer, and this is distinctly satisfactory, for it is hardly necessary to point out nowadays that the consumer who keeps a small number of lamps burning long hours is one to be encouraged.

The expenditure for the year is a matter of some £22,000, nearly £17,000 of which has been spent on machinery and buildings. The increase in the output is 383,633 units, which has been obtained by an increase in the total cost of production of £3,216; the gross profits, however, showed an advance from £34,371 to £41,681, practically £7,309. The following table shows the increase:—

Output.	Capital expenditure.	Working costs.	Gross profits.
383,633 units.	£21,997	£3,216	£7,309

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£252,162	£230,164
Number of units sold	1,898,362	—
Number of lamps connected ...	137,955	119,950
Revenue from sale of current ...	£41,681	£34,371
Net revenue	£14,639	—
Average price obtained per unit ...	5·25d.	—

Cost of Production.	£	Per unit.	1896.
Coal	5,468	·69d.	—
Oil, waste, water, and engine room stores	909	·12d.	—
Salaries and wages at generating station	3,605	·46d.	—
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	3,521 (Works' cost 1·69d.)	·45d.	—
Rent, rates and taxes	2,597	·33d.	—
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	3,928	·50d.	—
Depreciation of buildings and plant account	—	—	—
Renewal fund account	—	—	—
Total	£20,023	2·55d.	

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	41,681	0	0	5·25d.
Meter rents, &c.	1,323	0	0	—
Supply of steam	—			—
Transfer fees	—			—
Other items	17	0	0	—
Total	£43,021	0	0	5·25d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·55d.; works' cost, 1·69d.

Charing Cross and Strand Electricity Supply Corporation, Limited.

There has been no abatement of prosperity during the past year, and the Charing Cross Corporation may be now ranked among the soundest of the metropolitan supply companies. 34,078 additional lamps have been connected to the mains, an increase of 53·7 per cent. on the lamps connected in 1896. The output also shows a considerable increase upon that of 1896; in fact, some 33⅓ per cent. The capital expenditure for the past 12 months has been, however, somewhat heavy, being, in fact, £48,166. Of this sum, £24,693 has been spent on machinery, £12,017 on mains, and £5,806 on buildings, so it may be taken for granted that the full benefit of this additional expenditure has not yet been realised.

The following table shows the increase:—

Capital expenditure.	Output in units.	Cost of production.	Increase in gross revenue.
£48,166	671.108	£6,283	£9,922

It will be noted that the total cost of production per unit is identical with the figures for last year. Although the item for fuel is higher than last year, we may expect that, when the system is in complete working order, it will be very much reduced.

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£357,770	£309,604
Number of units sold	2,615,508	1,944,402
Number of lamps connected	107,522	73,464
Revenue from sale of current	£48,027	£38,105
Net revenue	£18,907	£15,289
Average price obtained per unit ...	4·4d.	4·69d.

Cost of Production.	£	Per unit.	1896.
Coal	10,349	·95d.	·87d.
Oil, waste, water, and engine room stores	997	·09d.	·08d.
Salaries and wages at generating station	5,110	·47d.	·46d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	2,308 (Works' cost 1·72d.)	·21d.	·26d.
Rent, rates and taxes	2,467	·23d.	·25d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	3,494	·32d.	·35d.
Depreciation of buildings and plant account	—	—	—
Renewal fund account	—	—	—
Total	£24,725	2·27d.	2·27d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	48,027	0	0	4·4d.
Meter rents, &c.	582	0	0	—
Supply of steam	—			—
Transfer fees	—			—
Other items	272	0	0	—
Total	£48,881	0	0	4·4d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·27d.; works' cost, 1·72d.

Dover Electricity Supply Company.

It is yet too early for the accounts of this company to show any beneficial results from the supply of electrical energy for the municipal tramways. It will be doubtless remembered that an agreement exists between this company and the Dover Corporation for the supply of electricity for tramway purposes, on what are undoubtedly favourable terms, as far as the company is concerned. The tramways, however, did not commence to to run before September, consequently, one cannot expect that the company has yet realised to what extent their position will be improved. It is significant, however, that the number of units sold has increased from 154,200 to 234,074, though the lamps that have been added to the circuits, 2,233, are no doubt in a great measure responsible for the increased consumption. The accounts for 1898 will be distinctly interesting, for they will reveal the practical advantages that are likely to accrue from the combined supply of electricity for lighting and tramway purposes. The following table shows the increase in capital, working costs, and output:—

Increase.			
Capital expenditure.	Output in units.	Working expenses.	Revenue from sale of current.
£11,932	79 874	£802	£2,985

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£62,836	£50,904
Number of units sold	234,074	154,200
Number of lamps connected	10,137	7,904
Revenue from sale of current	£5,059	£2,674
Net revenue	£1,178	—
Average price obtained per unit	5·16d.	4·14d.

Cost of production.	£	Per unit.	1896.
Coal	1 631	1·67d.	1 634.
Oil, waste, water, and engine room stores	160	·16d.	15d.
Salaries and wages at generating station	1,004	1·03d.	1·43d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	439 (Works cost 2 30d.)	·45d.	·27d.
Rent, rates and taxes	115	·12d.	·18d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	721	·74d.	1·27d.
Depreciation of buildings and plant account	—	—	—
Renewal fund account	—	—	—
Total	£4,070	4·17d.	4·92d.

Revenue.	£ s. d.	Average price obtained per unit.
By sale of current	5,059 0 0	5·16d.
Meter rents, &c.	114 0 0	—
Supply of steam	—	—
Transfer fees	—	—
Other items	74 0 0	—
Total	£5,247 0 0	5·16d.

Total cost per unit (exclusive of depreciation and renewal accounts), 4·17d.; works' cost, 2·30d.

County of London and Brush Provincial Electric Lighting Company, Limited.

The fourth annual meeting of this company was held on Monday at Winchester House, Lord Rathmore presiding.

The Chairman congratulated the shareholders on the steady progress which had been made by the company since their last meeting, on the good position in which they stood, and on the encouraging prospect which seemed to be opening for them. The net revenue for 1897 amounted to £20,875, as against £5,904 in 1896, while the gross receipts had increased from £8,485 to £25,371. A large proportion of these receipts arose from profits on investments realised. They had derived already a substantial profit from their London stations, amounting to £2,521 from St. Luke's and to £1,281 from Wandsworth. When they remembered what exceptional difficulties they experienced in the preparatory stages, and bore in mind that their two stations were only started for the supply of current during the past year—in the case of St. Luke's so recently as September last—those earnings were on the whole as large as they could reasonably have expected. The remainder of the ordinary share capital had been issued, making the total of capital paid £509,808, and leaving £90,000 which fell due this year. A substantial premium was received on the second issue of the ordinary shares, and this was applied to reducing the preliminary expenses, writing off costs in connection with provisional orders, and in increasing their reserve fund, which now stood at £5,000. The loans against security had been reduced from £53,600 in 1896 to £29,700. The sundry creditors amounted to £58,344, which was nearly all represented by plant, machinery, and cables, and was more than covered by the amount of sundry debtors on the other side of the balance-sheet. As to the assets, a further sum of £141,066 had been invested in their London districts. The preliminary expenses, which stood in 1895 at £18,478, had been reduced from time to time, and now amounted to only £8,800. As to their investments, some changes had occurred during the year, the most important of which was, that they had disposed of their interest in the Bournemouth station. The sundry debtors amounted to £71,545. This was largely in respect of their interest in the Bournemouth and district company, and it had now nearly all been collected. Their metropolitan stations were those to which they looked for their largest profits in the future. They retained an interest in the Bournemouth district, represented by ordinary shares. In the Dover company they still held practically the whole of the ordinary shares, and there seemed to be a good future before it. A dividend of 3 per cent. had been paid on the share capital of the Richmond company, and the whole of this dividend had gone into this company's coffers. The broad policy adopted by the company from the first in dealing with electrical supply for the County of London had been the establishment of two large generating stations—one on the north side and one on the south side of the river—each capable of meeting the wants not only of its immediate neighbourhood, but also of supplying the requirements of other localities for which they had hoped to obtain lighting orders. At the present moment they had by far the largest area of any electric lighting company in London. Their plan was based on the belief that such a policy would be found to be more economical and satisfactory than that of setting up smaller generating stations. He ventured to suggest to the vestries of the smaller areas of London who might be now thinking of embarking on electric lighting schemes of their own to ponder whether it might not be wiser to supply their wants in that direction by means of established companies—their own, for instance, which, owing to its larger preparations for business and its special technical experience, must be able, presumably, to give a more satisfactory supply, and at moderate rates, without any material reduction of its just profits. They had erected a fine station in the City Road, adjoining the Regent's Canal, so that the carriage of their coal and other material would be cheap and easy. The building at St. Luke's was finished, and the plant installed there was capable of supplying the equivalent of 80,000 8-candle-power lamps connected. They had good ground, he thought, for expecting that the demand for electric light in the St. Luke's and Clerkenwell district would steadily increase. For the eastern portion of Holborn the provisional order was confirmed to them in the last session of Parliament, and work having been at once commenced, current was now available. As to the western portion of Holborn, and also St. Giles-in-the-Fields, they had secured the consent of the local authorities to their application for provisional orders, which now awaited the sanction of Parliament. There were several other districts on the north side of the Thames and in the East-end of London, into some of which they had already obtained, while for others they were seeking the necessary authority to enter, and all of which they would be able to supply for years to come from their station in the City Road. So far he had been speaking of electric lighting only; but they were confirmed in their anticipations of a large demand also in those districts for a supply of electric current for motive power. Special mains for the supply of such current had been laid throughout the principal thoroughfares, and he believed that all preparations had been completed, and that that evening the batteries would be charged for the service. Their Wandsworth station was completed, and the plant now installed there had a capacity of supplying more than 40,000 8-candle lamps power connected, while there was space in the building for machinery to supply three times that number. From that vast area a very encouraging demand had already sprung up; and in Camberwell there was already a considerable demand for motive power as well as for electric lighting. The policy involved, no doubt, heavy capital expenditure at first and a certain delay in obtaining a substantial revenue in return, but they had done with large capital expenditure for years to come. They had paid no dividend yet on their ordinary shares. When, however, they allotted 10,000 ordinary £10 shares last December, their market value was £15, and they were allotted at par to their ordinary shareholders in the proportion of one share for three already held, and this was equal to a dividend of about 5 per cent. for the last three years.

Mr. J. B. Braithwaite, jun., seconded the adoption of the report, which was adopted.

A resolution increasing the directors' remuneration to £2,000 for 1898 was then carried.

The Oxford Electric Company, Limited.

The report of the directors states that the revenue account shows a profit for the year of £3,996 17s. 5d., to which has to be added £13 17s. 6d. (the difference between the receipts from share premiums and the expenses attending the redemption of the old debentures) and £537 7s. 6d., the amount brought forward from last year's account making a total of £4,548 2s. 5d. After deducting £202 15s. 2d. on account of the expenses attending issue of debenture capital, and providing £1,499 1s. 10d. for debenture and loan interest, the available balance is £2,846 5s. 5d., which the directors propose to appropriate as follows:—£500 to a fund to provide for future renewals of machinery and plant, and £2,327 8s. in payment of a dividend at the rate of 5 per cent. per annum upon the capital (the new shares issued in March ranking for dividend, as provided by the prospectus, from the average date of payment of the instalments thereon), leaving a balance of £18 17s. 5d. to be carried forward to next year's account. The £25,000 of 5 per cent. debentures outstanding at the date of last accounts have been redeemed at a bonus of 5 per cent., and replaced by an issue of £35,000 debenture stock at 4 per cent. interest. The premiums received on a further issue of 2,000 shares made in March last exceeded the bonus paid on the redemption of the debentures by £13 17s. 6d., which has been carried to the revenue account. The expenses attending the issue of the new debentures, including the sum of £79 10s. which previously stood to the debit of capital account, amount to £608 5s. 6d., whereof £202 15s. 2d. had been debited to the revenue of the year, and the balance carried forward, to be liquidated out of the revenue of the next two years. The gross receipts have been to some extent affected by a reduction in the price of current to consumers as from January 1st, 1897, but the directors confidently expect that this liberal policy will yield advantageous results in the near future. Since the last report 2,630 8-C.P. lamps or the equivalent, have been connected with the mains, bringing the total on December 31st last up to the equivalent of 21,364 8-C.P. lamps. The plant at the generating station has been

increased during the year by a 500-H.P. engine and a boiler of 200-H.P. capacity. A new transformer station has also been equipped in Ship Street, and two additional transformers connected to the system. A line of 3-inch iron pipes has been laid from the works at Osney to a central position in the city, to provide for extensions of the high tension feeding system, and to enable the supply to be controlled entirely from the works. The cost of these additions to plant and extensions has been provided by the proceeds of the 2,000 shares issued during the year.

Chelsea Electricity Supply Company, Limited.

The directors' report states that in October, 1897, an issue of 8,000 ordinary shares of £5 each was made, and was fully subscribed. The final instalment on these shares, due on January 1st, 1898, has now been paid, and a Stock Exchange quotation for the new issue has been applied for. The balance of premium received in 1897 in respect of this issue, after deducting the expenses of issue, amounts to £21,983 5s. 6d., and, following the course adopted in the accounts of previous years, a portion of this has been applied to the extinction of the legal and other extraordinary expenses incurred during the year. The balance remaining, £20,851 15s. 5d., has been placed to the reserve fund, making the total of that fund £35,717 9s. 5d. The sum of £2,000 has been added to the renewals and depreciation fund, out of the net revenue. After deducting this amount, and after payment of interest on debenture stock (£2,700), there remains a balance available for distribution of £11,344 5s. 2d., including £1,526 17s. 4d. brought forward from last year.

The directors recommend that this balance shall be applied as under:—

	£	s.	d.
Interim dividend of 6 per cent. per annum on the preference shares for the half-year to June 30th, 1897 (paid July 1st, 1897)	900	0	0
Interim dividend on 26,000 ordinary shares for the half-year to June 30th, 1897, at the rate of 5 per cent. per annum (paid July 1st, 1897)	3,250	0	0
Dividend of 6 per cent. per annum on the preference shares for the half-year, to December 31st, 1897 ...	900	0	0
Dividend on 26,000 ordinary shares for the half-year to December 31st, 1897, at the rate of 7 per cent. per annum, making a total dividend of 6 per cent. for the year	4,550	0	0
Dividend at the rate of 6 per cent. per annum on the instalments of £1 per share from the due date of the instalment to December 31st, 1897, on the new issue of 8,000 shares	92	1	1
Balance to be carried to next account	1,652	4	1
	£11,344	5	2

The number of lamps connected on December 31st, 1897, was 96,638, an addition of 16,178 during the year. A large part of the capital expenditure has been incurred in the purchase of freehold land in Pavilion Road, and building thereon a substantial sub-station, in the extension of the new generating station at Alpha Place, and also in the purchase of some leasehold property. Considerable amounts have also been spent on generating machinery and on mains to supply the increase in demand.

At an extraordinary general meeting, held on February 2nd last, the shareholders confirmed their approval of a Bill for the compulsory purchase of certain properties required for the development of the business.

House-to-House Electric Light Supply Company.

The tenth ordinary general meeting of the shareholders of the above company was held on Friday last at Winchester House, Old Broad Street, Mr. Henry Raniré Beeton (the chairman) presiding.

The report and accounts having been taken as read, the Chairman said: Gentlemen, in moving the adoption of the report and accounts, I should like to call attention to the fact that the satisfactory features which have characterised the working of our undertaking of late years, have repeated themselves during the past year. The extension in the demand for electricity has continued undiminished, and a further reduction in the cost of production has been effected; so that our increased revenue has again been earned without any appreciable addition to our expenditure, and the increase of profit is larger than in any previous year in the company's history. In regard to the future, the applications so far received from new consumers during the current year exceed those received at the corresponding date last year, and although the cost of production cannot be indefinitely reduced, there is no reason to believe that finality has been reached in this particular. In order to obtain the satisfactory results which our accounts disclose, we have had to adopt, wherever it was possible to do so, the best machinery and methods which advancing experience has made available. This is no reflection upon our system of supply, which, I think, we are justified in regarding as the best suited to a district such as ours, but is a necessity incident to all systems in the earlier stages of the industry. Already our works' cost is nearly as low as those of other metropolitan supply companies whose output is four and five times larger than ours, while our capital outlay per unit of productive power compares most favourable with that of our neighbours, notwithstanding that most of them are more favourably situated than we are. The credit of this position, of which we may justly be proud, is largely due to the ability and devotion of the company's engineer and manager, Mr. Bowden, to whom the thanks of the shareholders are due. The effect, however, of the rapid development in the methods of supply and distribution during the past eight years in which the foundation of our business has been laid, has been that some of our plant has been superseded in the process. In these circumstances, our capital account has had to suffer somewhat for the benefit of our revenue account, and we have frankly recognised in our report that the normal provision for depreciation must accordingly be supplemented in future years if our capital is to remain intact when our undertaking falls in to the local authority under the purchase clause of our provisional order. I am happy to say, however, that so far as we can ascertain our loss of capital from this cause, it is already much more than compensated by the value of the goodwill which we possess to-day, and that as the value of our goodwill declines with the lapse of our concession, such loss can be provided out of revenue without any additional burden on profits, owing to the extinction of the preliminary expenses which has now been accomplished. Before concluding my observations, I should like to call attention to a plan which we have recently inaugurated for advancing the popularity of the electric light in our district, which we commend to the notice of our consumers and to the emulation of our neighbours. Alone among the electric lighting companies in the metropolis to-day, we are prepared to give householders a limited installation, not only free of all initial expense, but free from any additional charge for electricity. We believe that when consumers realise that they can enjoy the electric light without incurring any capital expenditure, and especially leasehold consumers whose expenditure would not benefit their own property, many will be disposed to adopt the electric light in preference to gas, and as we can make a larger profit on the same number of lights in the form of many small installations than in the form of fewer large installations, it will pay us to expend the capital necessary to extend our business in this way.

Mr. R. A. Germaine seconded the motion, and the report was adopted.

The retiring directors and auditors having been re-elected, the proceedings terminated with a vote of thanks to the chairman for presiding.

The Windsor Electrical Installation Company, Limited.

The directors' report states that the business of the company is progressing satisfactorily. The number of lamps installed on December 31st, 1897, was equivalent to 4,985 of 8-candle power; since that date 395 have been added. In the course of the year a new engine, twice the size of the original ones, has been added, and the storage cell capacity has also been doubled. Extension of mains have been made in St. Leonard's Road, Osborne Road, and King's road. The net profit for the year is £1,256 16s. 7½d., as shown on the net revenue account, No. 4, and out of this sum the directors recommend that a dividend of 4 per cent., free of income-tax, be declared on the paid-up capital of the company, the dividend on the new shares being calculated from the dates of allotment and call. This will absorb £652 7s. 4d., leaving a balance of £604 9s. 3½d. to carry forward. The directors have now been in office for two years without any remuneration whatever, and in view of the very satisfactory progress of the company, they will, at the general meeting, ask the shareholders for a vote on account of their past services. Mr. A. W. H. Good resigned his position as secretary of the company in the early part of the year, and your directors did not consider it necessary to appoint another permanent secretary, as Mr. A. W. Shipley, in addition to being a director of the company, kindly accepted the position of managing director, and the board consider themselves very fortunate in securing his valuable services. It is proposed to issue the remaining capital—£5,000—during the current year. The directors recommend that the shares be issued at a premium of 2s. 6d. per share, and any shareholders desiring an allotment should apply at the company's offices for a form of application. The allotment will be *pro rata* to existing holdings, but any shareholder not applying within one month of the date of this report will be deemed to have renounced his right to an allotment. Current is now being supplied at 7d. per unit, but the directors hope to reduce the price to 6½d. when 8,000 C.P. lamps or their equivalent are installed. This reduction in Windsor is equal to 3d. per 1,000 feet of gas.

South London Electric Supply Corporation.

The first report of the directors, with accounts to December 31st last, to be presented to the ordinary general meeting to be held in London on Monday, states that the works of the corporation are proceeding in a satisfactory manner. The first subject which claimed the board's attention was that of obtaining a suitable site for the central station and dust destructor, which, by virtue of an agreement with the vestry, had to be approved by that authority. This presented much difficulty, and caused unavoidable delay. The inconvenience was, however, fully compensated for by the ultimate acquisition of the most favourable site for the purposes of the corporation within the parish of Lambeth. The land is freehold, and consists of three acres on the north-west side of the London, Chatham and Dover Railway, between Loughborough Junction and Denmark Hill stations. Possession was obtained at Michaelmas, 1897, when the contractors, Manlove, Alliott & Co., Limited, were instructed to proceed with the erection of the necessary buildings and dust destructor. Arrangements have been made by which current is being obtained from a neighbouring electric supply company, pending the completion of the central station, and thus the nucleus of a promising business is being formed. About two and a half months have elapsed since a portion of the mains were made available for a supply of current. The total num-

ber of 8-C.P. lamps for which energy has already been applied for amounts to 2,659. The whole of the issue of share capital offered last March, amounting to £325,000, has been subscribed. This places the corporation in a strong financial position, and obviates the necessity of curtailing the contracts which at one time appeared inevitable. The action of the board in placing the balance of the original issue which was not applied for when the corporation was brought out has been somewhat criticised. The directors are satisfied that they acted in the best interests of the corporation, and are confident their action will be supported by the general body of the shareholders. As so short a time has elapsed since the commencement of operations, and no electric supply had been made up to the end of 1897, the accounts merely take the form of a balance-sheet to December 31st, showing the position of the company at that date. Mains already laid are shown on maps which can be seen at the corporation's offices, and amount in all to 21 miles laid in about 8 miles of streets. The necessary machinery and plant is being constructed as rapidly as possible.

Sheffield Electric Light and Power Company.

The report of the directors for the past year states that the net profit, including a balance of £99 brought forward, is £11,492, which it is proposed should be appropriated as follows:—Interest on debentures, £1,125; in payment of a dividend of 12½ per cent., free of income-tax, £9,464; and carry forward £903. The last issue of shares at £2 premium was wholly taken up, and realised a premium of £3,792, which was applied to costs of increasing capital, £200; to depreciation fund, £1,903, making that £6,643; and to reserve, £1,689, bringing that fund up to £2,970. On January 1st, 1897, the price of current was reduced from 6d. to 5d. per unit, and an increased demand had followed. The amount derived from the sale of the current during the five completed years of the company's operations were—1893, £3,555; 1894, £4,849; 1895, £6,935; 1896, £11,258; 1897, £14,319. During the year £19,980 had been expended upon machinery, mains, and other appliances, being £1,600 more than in the preceding year. In consequence of the difficulty in obtaining new machinery from English manufacturers, owing to the dispute in the engineering trades, the directors in July last notified their inability to accept new customers for attachment before Christmas. The difficulties are now removed, as new machinery had been laid down. At the annual meeting the shareholders will be asked to approve of an agreement for the sale of their undertaking to the Corporation. The capital expenditure is fixed at £124,472, and the Corporation agrees to pay £220 Sheffield 2½ per cent. redeemable stock, or £213 8s. in cash for each £100 of the capital property expended by the company. The sale takes place as from December 31st, and until its completion the company is entitled to a dividend of 10 per cent. per annum upon their paid up capital. The directors think the terms proposed are fair and equitable, and they advise the shareholders to accept them.

Hastings and St. Leonards Electric Light Company.

The directors' report congratulates the shareholders upon the increasing business of the company, and points with much satisfaction to the fact that the increased income has been obtained at a very small increase of cost, the receipts for the past year having exceeded those of 1896 by £1,633, whilst the expenditure or works' cost has only increased £157. This result has been obtained by constant watchfulness of the staff, in the expenditure of fuel, and by improvements made in the machinery, whereby greater economy has been possible. Since the last ordinary general meeting the Corporation has taken and paid for the mains, lamp-posts, and other plant relating exclusively to the public lighting, and consequently the repairs to, and renewals of, such plant now fall on the Corporation, although the company is still supplying the current, and will probably continue to do so for some time longer. The directors have also (with the sanction of the shareholders) entered into a provisional contract with the Corporation for the sale of the undertaking, and the Corporation is applying to the Board of Trade for a provisional order to enable it to carry the contract into effect, but, in the meantime, the directors are carrying on the business for the benefit of the shareholders, as if no such contract existed. The result of the past year's trading is exceedingly satisfactory, and shows a net profit of £1,990 18s. 4d., out of which the directors recommend a dividend at the rate of 6 per cent. (which will exhaust £1,633 4s.) to be paid; £300 to be placed to reserve, and the balance of £57 14s. 4d. to be carried forward.

Isle of Man Tramways and Electric Power Company.

The annual meeting of this company was held at Douglas yesterday week.

The directors' report submitted stated that the balance available was £11,155, and recommended dividends at the rates of 6 per cent. per annum on the preference and 7 per cent. per annum on the ordinary shares.

Mr. A. Bruce, chairman of directors, in moving the adoption of the report and accounts, said the extension of the electric system from Laxey to Ramsey would be open next July, and he anticipated that this would be a source of considerable revenue to the company.

The motion was adopted.

Messrs. A. Bruce and F. G. Callow, the retiring directors, were re-elected, and Messrs. William Aldred, Son & Co., Manchester, were re-appointed auditors.

Birmingham Electric Supply Company.

A meeting of this company was held last week at Birmingham.

Mr. Buckley, chairman, in proposing the adoption of the report, congratulated the shareholders on their receiving, for the first time in the history of the company, a 5 per cent. dividend. The prospects of the future were very hopeful, as was shown by the continued increase in the business. During 1895 they supplied 18,199 lamps; in 1896 the number was 25,876, and last year 39,232. Their supply of current in 1895 was 490,000 units, 1896 756,000, and last year 1,133,000 units. Therefore he thought he was justified in saying that the company was created for a proper purpose, and that there was a field for their operations. By the aid of wall diagrams he then showed to the satisfaction of the shareholders how the supply of their light was extending not only among manufacturers, but also to the residential parts of the city. This increased output had necessitated enlargement and additional plant at both the Dale End and Water Street premises, and he thought that they had reason to look upon the future with the greatest satisfaction. With regard to the proposal of the Corporation to take over the concern, one of the council committees was looking into the matter to see if it was advisable to recommend the purchase; and the shareholders would therefore see that it was impossible for him to make any statement on the question at present. It would be wrong to the Corporation and inimical to the company. Whatever was done, however, would be subject to the approval and ratification of the shareholders. As to the increase of capital, the directors would in this case also consult the shareholders as to the time when the new shares should be issued. The motion was then adopted.

Crompton & Co., Limited.

We have received the following circular signed by Mr. John Trotter, chairman:—"The directors have to inform the shareholders that, in consequence of certain differences of opinion between themselves and Mr. J. F. Albright as to the management of the company's business, Mr. Albright is relinquishing his position as a managing director, and has also informed the board that as soon as may be convenient to the company, he is desirous of resigning his position as a director. The directors regret that this course should have become necessary. To provide for the future management of the company, the directors have appointed Mr. F. R. Reeves, the company's secretary, to the post of general manager, Mr. R. E. Crompton continuing to superintend the technical part of the company's business. The directors are pleased to be able to inform the shareholders that arrangements have been made by which Mr. Albright undertakes for 12 months to give the company all advice and information reasonably in his power."

Stock Exchange Notices.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to—W. T. Henley's Telegraph Works Company, Limited—Further issue of 2,500 ordinary shares.

The Stock Exchange Committee has appointed Wednesday, March 23rd, a special settling day in County of London and Brush Provincial Electric Lighting Company, Limited — Further issue of 10,000 ordinary shares of £10 each, £2 paid, Nos. 30,001 to 40,000; and has ordered to be quoted in the Official List:—County of London and Brush Provincial Electric Lighting Company, Limited—Further issue of 10,000 ordinary shares, Nos. 30,001 to 40,000.

The Direct Spanish Telegraph Company, Limited.—The board has decided to recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend, free of income-tax, at the rate of 4 per cent. per annum on the ordinary shares, both for the half-year ended December 31st, 1897.

Chelsea Electricity Supply Company, Limited.—The annual meeting of this company was held yesterday afternoon, at Cadogan Gardens, S.W., for the adoption of the report and accounts for 1897. A report will appear in our next issue.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending March 11th, 1898, were £2,259 13s. 2d.; corresponding period, 1897, £2,125 17s. 6d.; increase, £133 15s. 8d.

The City and South London Railway Company.—The receipts for the week ending March 13th, 1898, were £1,077; week ending March 14th, 1897, £1,031; increase, £46; total receipts for half-year, 1898, £11,796; corresponding period, 1897, £11,806; decrease, £10.

The Cuba Submarine Telegraph Company.—The receipts for the month of November were £3,413, as compared with £4,545 in the corresponding month of last year.

The Dover Corporation Electric Tramways.—The receipts for the week ending March 12th, 1898, £100 5s. 9d.; total receipts to March 12th, 1898, £1,048 11s. 6d.

The Dublin United Tramways Company.—The receipts for week ending Friday, March 11th, 1898, were £381 4s. 1d.; corresponding week last year, £392 11s.; decrease, £11 6s. 11d.; passengers carried, 65,867; corresponding week last year, 63,023; aggregate to date, £3,975 13s. 5d.; aggregate to date last year, £4,305 18s. 6d.; decrease to date, £330 5s. 1d.; mileage open, 8 miles. Cars, 1898, 209; 1897, 227. Miles, 1898, 18,887; 1897, 17,865.

The Liverpool Overhead Railway Company.—The receipts for the week ending March 13th, 1898, amounted to £1,330; corresponding week last year, £1,280; increase, £50.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending March 11th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,996.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue	NAME.	Stock or Shares. †	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, March 9th.	Closing Quotation, March 16th.	Business done during week ended March 16th, 1898. Highest.	Lowest
137,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %			100 104	100 104	103	
25,000	Amazon Telegraph, Limited, shares	10				6½ 7½	7 8		
125,000	Do. do. 5% Debs. Red.	100				93 — 96	93 — 96		
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	59 61	59 61	61	60½
3,038,020£	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	108½ 109½	108½ 109½	109½	108
3,038,020£	Do. do. Defd.	Stock				11⅝ 12⅛	11½ 12	11⅝	11½
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %			16⅝ 17¼	16⅝ 17½	17 1/16	16 5/16
75,000£	Do. do. 5 %, Debs., 2nd series, 1926	100	5 %			112 6	112 116		
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	4 %	4 %		3 3½	3 3½		
10,000,000$	Commercial Cable Co.	$100	7 %	7 %		187 192	187 192	189½	
918,297£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock				106 108	106 108	107	105
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %		3/16 5/16	3/16 5/16		
16,000	Cuba Teleg., Ltd.	10	8 %	8 %		6½ 7½	6½ 7½	7½	6 13/16
6,000	Do. 10 % Pref.	10	10 %	10 %		14½ 15½	14½ 15½	15	14 9/16
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 5	4 5		
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 11	10 11	10⅜	
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	4½%	103 106%	3 106½		
60,710	Direct United States Cable, Ltd.	20	2½%	2½%		10⅜ 11¼	10⅜ 11¼	11 1/16	10 15/16
120,000	Direct West India Cable 4½% Reg. Deb	100				93 —101	93 —101	100	99½
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%		17⅜ 18½	17⅜ 18½	18½	17⅜
70,000	Do. 6 % Cum. Pref.	10	6	6%		18½ 19½	18½ 19½	19	18⅜
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5%		100 103	100 103		
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%		129 132	128 131	131½	129
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7½		18⅜ 19¼	18⅜ 19¼	19⅛	18⅞
25,200£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,949, 3,976 to 4,325	100	5 %	5%		99 103	99 103		
100,500£	Do. do. Bearer, 1,950—3,975 and 4,327—6,480	100	5 %	5%		100 103	100 103		
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4%		130 133	128 131	130	
35,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5%		99 103	99 103		
46,500	Do. do. do. to bearer, 2,344 to 5,580	100	5 %	5%		100 1 3	100 103		
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4%		102 —105	102 105		
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%		108 -111%	108 111 %		
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%		11⅜ 12¼	11⅜ 12¼	12 1/16	11 11/16
180,042	Do. do. 6 % Pref.	10	6 %	6%		17⅜ 18¼	17½ 18	17⅝	17⅜
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%		29 30	29 30		
160,000£	Do. do. do. 5 % Debs.	100	5 %	5%		100 —103	100 —103		
97,000	Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100				95 —100	95 —100		
17,000	Indo-European Teleg., Ltd.	25	10 %	10%		52 — 55	52 — 55		
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%		106 109	106 —109		
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000	5	4 %			2 — 2¼	2 — 2¼		
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6⅜ 6⅝	6⅜ 6⅝	6 11/16	6⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 18	16 18	17½	
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 17	15 17	15⅝	
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜ 6⅛	5⅜ 6⅛	6 1/16	5⅝
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —109	102 107	104½	104
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %		⅜ ½	⅜ ½		
100,000£	Pacific and European Tel., Ltd., 4 % Guar Debs, 1 to 1,000	100	4 %	4 %		105 —108	105 108		
11,839	Reuter's Ltd.	8	5 %	5 %		8 9	8 9		
3,381	Submarine Cables Trust	Cert.				139 144	139 144	140	
58,000	United River Plate Teleph., Ltd.	5	4 %			4 4½	4 4½		
146,733£	Do. do. 5 % Debs.	Stock	5 %			106 09	106 109	106½	102
15,609	West African Teleg., Ltd., 7,561 to 23,169	10	4 %	nil		4 5	4 — 5		
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %		101 104	101 104		
54,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %		11¼ 11⅜	11½ 12	11 1/16	11⅜
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %		7½ 8	7½ 8		
33,129	Do. do. do. Def. Ord.	7½	1 %			3½ 3⅝	4 4½	4 3/16	4
389,521	Do. do. do. 4 % Deb. Stock Red.	Stock				106 —109	106 —109	107⅛	
88,321	West India and Panama Teleg., Ltd.	10	1%	1 %		½ ⅝	½ ⅝	⅝	
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %		8 — 8¼	8 8½		
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %		5 7	5 7	6½	5½
80,000£	Do. do. 5 % Debs. No. 1 to 1,600	100	5 %	5 %		105 108	105 108		
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	7 %	7%		105 110	105 —110		
160,100£	Do. do. 5 % Ster. Bonds.	100	6 %	6%		100 105	100 —105		

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13½ 14½	13½ 14½		
20,000	Do. do. do. do. 4½ % Cum. Pref.	5				6 — 6½	6½ — 6⅝	6 9/16	6½
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277	5	5 %	5 %		11½ 12	11½ 11⅞	11⅞	11⅝
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%		115 —117	115 —117	116½	
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	7 %	10 %	28 29	26 27 xd	28½	26½
10,000	Do. do. Prov. Certs.	5			10 %	27½ 28½	26 27 xd	26½	26½
10,000	Do. do. Nos. 90,001 to 100,000 £2 pd.	10				13½ 14½	13 14	13⅝	13
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ 18½	17½ 18½xd	18⅜	17⅝
40,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid		5 %	5 %	5 %	129 —134	129 134		
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	nil	nil	nil	14⅜ 15½	14⅜ 15½	15⅛	14⅜
20,000	Do. do. do. 6% Pref., 40,001—60,000	10	6 %	6 %	6 %	15⅜ 16½	15⅜ 16½	16 5/16	16 3/16
17,400	Edmundsons Elec. Corp., Ltd, ord. shares 1—17,400	3				.....	3½ 3¾	3 7/16	
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5				11 — 12	11 — 12	11⅛	11½
10,000	Do. do. 7 % Cum. Pref.	5				11⅜ 12½	11⅜ 12½	11⅞	
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	4 %	5 %		20½ 21½	20½ 21½	21⅛	21
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10				20 — 21	20½ 21½	21½	20⅜
220,000£	Do. 4½% first mortgage debenture stock		4½%	4½%		117 — 121	117 —121		
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	20 — 21	19½ 20½xd	20⅛	20¼
19,980£	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	10½%	14½%	18½ 19½	18½ 19½	19	
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 11		
50,000	Do. do. 4 % Deb. stock Red.	Stock			4 %	107 —110	107 —110		
43,341	South London Electricity Supply, Ord., £2 paid	5				2⅜ 3	2½ 2½	2 15/16	2 3/16
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000	5	7 %	9 %	12 %	17½ 18½	17½ 18½	18	17⅝

* Subject to Founder's Shares.

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

§ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, March 9th.	Closing Quotation March 16th.	Business done during week ended Mar. 16th, 1898 Highest.	Lowest
30,000	British Electric Traction	10	...	...	...	16⅜ — 17¼	16⅜ — 17¼	17	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2⅛ — 2⅜	2⅛ — 2⅜	...	...
125,000	Do. do. 4½ % Perp. Deb. Stock.	Stock	...	...	...	110 — 114	110 — 114	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 — 105	102 — 105	...	...
19 894	Central London Railway, Ord. Shares	10	...	...	...	10½ — 11	10½ — 10⅝	10⅝	10 9/16
129,179	Do. do. do. £6 paid	10	...	...	...	6¼ — 7	6½ — 6⅝	6½	...
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 2	1½ — 2	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅜ — 5	4⅜ — 4⅞	4⅞	...
630,000	City and South London Railway	Stock	1 1/16 %	1 1/16 %	1 7/8 %	67 — 69	66 — 68	68	66⅝
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	nil	...	...	2¼ — 2⅝	2¼ — 2⅝	2¼	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shares, £3 pd. 1 to 99,261	5	5 %	5½%	...	2½ — 3	2½ — 3	...	...
...	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	103 —105	103 —105	...	...
1 ...	Electric Construction, Ltd., 1 to 116,000	2	5 %	6 %	...	2⅜ — 2⅝	2⅜ — 2⅞	2⅞	2 1/16
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343	2	7 %	7 %	...	3½ — 3⅝	3½ — 3⅝	...	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 —108	106 —108	107¼	106
91,1 6	Elmore's Patent Cop Depos., Ltd., 1 to 70,000 ...	2	...	...	...	⅛ — ¼	⅛ — ¼	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm	2	...	...	...	⅛ — ⅛	⅛ — ⅛	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600	10	10½%	..	...	9 — 11	9 — 11	...	...
12,500	Hedley's (W T.) Telegraph Works, Ltd., Ord. ...	10	8 %	10 %	12 %	23 — 24	23½ — 23¾xd	23⅞	22⅝
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	19 — 20	18½ — 19½xd	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½ %	110 —115	110 — 115	112	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21½ — 22½	21½ — 22½	22 3/16	21⅜
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	104 —108	104 —108	106⅜	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼ %	10 11/16 — 10 13/16	10 11/16 — 10 13/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15⅝ — 16¼	15⅝ — 16¼	...	...
97,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	37 — 40	36 — 39 xd	39	36½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
540,000	Waterloo and City Railway, Ord. Stock	100	...	...	...	136 — 139	136 —139	139	135

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1895—0%; 1896—7%; 1897—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* **Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 10⅜.**

House-to-House Company, 4½% Debentures of £100, 107—109.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 17—18; 1st Preference Cumulative 6%, £5 (fully paid), 8½—9. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4—4½.

* **T. Parker, Ltd., £10 (fully paid), 14.**

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

STEAM RAISING BY WATER TUBE BOILERS.

The Gloucestershire Engineering Society was recently selected by Mr. H. W. Kolle, as the audience to which to expound his theories of the water tube boiler. Naturally Mr. Kolle is biased in favour of water tube boilers, and considers them as near perfection as boilers have yet arrived. It may be well, therefore, to review the eight requirements of a perfect steam boiler as enunciated by him. These are far more than eight in number, but we give them as arranged under eight heads, but divested of the curious lack of the rules of elementary construction which seems to cling to so many technical descriptions. They are as follows:—(1) Best materials for construction, perfect workmanship, durability, highest class fittings. (2) Great margin of strength, construction free of expansion stresses. (3) Sectional water space so arranged as to avoid general explosion. (4) A combustion chamber arranged to secure complete combustion before escape of gases to chimney. (5) Heating surface at right angles to the gas currents. (6) Constant and thorough circulation. (7) A steam and water capacity sufficient to prevent sudden change of pressure or water level. (8) Accessibility of parts for cleaning or repairs.

As the above requirements are claimed to exist in the Babcock boiler *par excellence*, we may not unfairly follow the claims and see if they are all substantiated. Of the first requirements there is no difficulty in using the best possible materials and workmanship, and the highest class of fittings. This is merely a matter of choice. The question of durability is an open one. Perhaps the worst fault of the water tube boiler is the short life of its internal brickwork or of its lower tubes when water is hard. We hope there is now no further use of cast-iron in any water tube boiler, but for a long time there was far too much cast-iron in the ends of the steam drums and in the tube headers, and the claim for best materials has at most only lately been tenable.

Claim (2) for large margin of strength can only be tenable if all parts are of wrought-iron or steel, and if any cast-iron is still used must be disallowed. Advocates of water tube boilers, while claiming great strength because of small diameter of parts, have thrown away such advantages by resorting to the wholly unsuitable metal cast-iron. Stresses from unequal expansion are provided against fairly well by the water tube arrangement. Claim (3) is fairly well earned. Claim (4) cannot be considered tenable. The gases from the fire rise up directly among a nest of cold tubes, and then enter the so-called combustion chamber—so-called by courtesy only. A combustion chamber placed behind a lot of water pipes cannot act as a combustion chamber if the pipes have done their duty. Moreover, the ordinary arrangement of the furnace is anything but good. There is no bridge, and the products of the fire rise directly amongst the tubes above them. A fire cannot be smokeless unless the products from it are mingled by sweeping over the whole fire surface and pass, *via* the bridge, to the combustion chamber beyond. Experience with Lancashire and Galloway boilers proves that even under the best conditions the presence of cross water pipes in the tubes beyond the bridge wall will induce smokiness. The water tube boiler as arranged in the Babcock type, must either burn smokeless fuel, or it must have its furnace arranged with an over-arching firebrick roof, so as to compel the gases to travel somewhat as in other forms of boilers. Combustion should be complete before the tubes are reached, or there will be very little later chance of securing this desirable result. As to claim (5) there is probably no particular value in this arrangement. Gases travelling across tubes only impinge on one-half the tube, and the other half is untouched. It is probably better that the gases should travel with the tubes, completely enveloping them. Claim (6) is fairly to be maintained. For stationary work the arrangement of sloping tubes is such as to indu e continuous circulation. Claim (7) is one on which great differences of opinion prevail. In a battery of boilers the smallness of capacity of each individual item is perhaps of little consequence. It is when there is but one boiler that the lack of steadiness becomes apparent and the water tube boiler gives least satisfaction. Of claim (8), that of accessibility for repairs, this, of course, depends on the arrangement possible with the seating. With ample space it can be secured. Our author is apt to lay far too much stress upon the heat transmission being hindered by the thick plates of the furnaces of large shell boilers. A single homogeneous thick plate does not readily burn; lap joints may burn, but it is the air space at the lap which causes this. Water tubes, though thin, often tear open in a most disastrous manner, and are not looked on as particularly safe by boiler insurance companies who prefer shell boilers despite Mr. Kolle's statement that they explode almost every day. Moreover, this statement is not borne out by fact. More water tube boilers explode per cent. of those at work than shell boilers. Nor have water tube boilers proved themselves to be economical as compared with shell boilers. Probably the marine class of land boiler as now made and arranged affords the best example of fuel economy and economy of space and bricks. The setting of the water tube boiler is

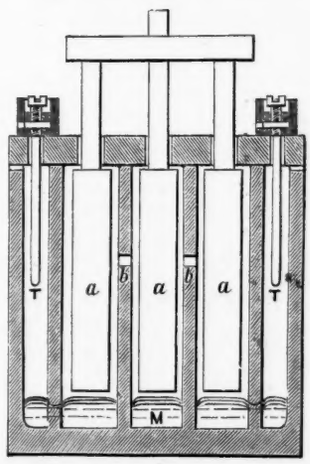
unfortunately somewhat tender and gives rise to great cooling effects from air leakage. In a less but similar degree the Lancashire boiler is exposed to the same losses. We have seen a good many tests reported of water tube boilers, but none to substantiate the claim for superiority over any other type. True a report was published which claimed, we believe, 13¼ lbs. evaporation although the chimney temperature was high, but who believed it? Water tube boilers have a future. There are places, thanks to the follies of architects, where water tube boilers are almost compulsory. At the same time, there is room for much improvement in their construction. The makers of them must get over that idea of small diameters. They make it a question of salvation, and it has not tended to better materials. Large shell boilers have had to face big pressures. No pandering to the devil for poor materials has been possible with them. Where a man has to deal with 200 lbs. pressure in a 12 feet shell he is obliged to be on the alert for good materials, but there is an idea that anything will do for 4 inches, hence the employment of cast-iron and the talk about the safety of small diameters. We fear this has to bear some of the responsibility for split tubes. It is far better to live up to a high pressure than to live down to a small diameter. While many engineers object to water tube boilers because of their small contents, others like them because they soon respond to a forced fire. Later practice seems to favour a combination of shell and water tube boilers so as to secure both the staying power and the sudden response to a pushed fire. Our author looks to the universal adoption in the near future of the water tube boiler and the superheater with high pressure. Water-tube boiler makers seem to have forgotten that the stress of present day pressures on the steam drums of water tube boilers is greater than the stress a few years back on shell boilers, which were then declared to have seen their last days, yet, if judged by the boiler of to-day, were only in their infancy. It is not safe to prophecy too closely on the limits of mechanical engineering.

THE SOCIÉTÉ INTÆRNATIONALE DES ELECTRICIENS.

The monthly sitting of the Société Internationale des Electriciens was held on March 2nd, 1898, at 8.30 p.m, with Dr. D'Arsonval in the chair.

The Secretary read the report of the last meeting, presented the new members, and spoke of the works published. The president announced the death of M. Gauthier-Villars, and expressed condolence. The committee proposed the following candidates for the official elections that will take place at the next meeting: President, M. Violle; vice-presidents, Messrs. Clérai and Monnier; treasurer, M. Violet; secretaries, Messrs. Abraham and Grosselin.

First, M. P. Janet presented, in the name of M. Bouchet, various interrupters and circuit breakers based on a new mode of breakage. In a box made of insulating material are arranged two cavities separated by an insulating partition; they are filled with mercury up to a



certain height; if a plunger is inserted into each cavity, the mercury rises, flows over the insulating partition, and closes the circuit. In the same way, in withdrawing the plungers, the mercury separates, returns into each cavity, and cuts the circuit. It might be feared that the mercury, bringing impurities with it, would leave a trail behind it; but experience has shown that after a long period of working—1,000 breaks, for instance, the traces left behind by the mercury were not sufficient to close the circuit.

On the basis of the above principle the inventor has constructed various models of interrupters. It is only necessary to put a lid on the box of insulating material; in the centre is a lever for working the plungers. This lid has on its sides two metal rods connected with external terminals. The mercury, as it rises, touches these rods and closes the circuit; we therefore get closing and breaking at three points.

M. Barbarat has arranged an interrupter with three plungers, *a*,*a*,*a*, for high tensions (see illustration), and with two insulating partitions, *b*, *b*. This apparatus has been tried with alternating currents at 12 amperes and 3,000 volts on the sector of the Champs Elysées. Magnetic circuit breakers have also been constructed with this mode of breaking. For this purpose a rod of iron is connected with the dippers, and is displaced within a solenoid traversed by the current. The mechanism is arranged so that the action of the electro-magnet on the armature is balanced at the beginning by the weight. As soon as the movement has begun, two springs placed at the sides and immediately set free, continue it, and raise the rod so as to bring about the breaking.

Various other instruments have been constructed, in particular an interrupting circuit breaker, and minimum circuit breaker. Two electromagnets have also been arranged one above the other; one to make and one to break the circuit. Thus the interrupter can be worked from a distance. M. P. Janet has worked in this manner the interrupter of a circuit of 100 lamps.

M. Barbarat then described the new underground cables with air insulation employed by the Telephone Administration of Paris. These cables are insulated with paper, and the insulation is ensured by injecting from time to time dry air under pressure. For this purpose, the compressed air is supplied by the compressed air company; it passes over chloride of calcium, and is sent into each cable by means of taps. This dried air removes every trace of dampness and ensures the insulation. Sometimes the operation can be facilitated by sending a workman to heat it on the spot.

These cables have been tried over long telephonic systems, and have given good results.

CROWDUS STORAGE BATTERY.

The following is the description of this battery referred to in our "Correspondence" columns, and is apparently a copy of a patent specification:—

This invention relates especially to that type of accumulators or secondary batteries known as the "heterogenous" formation, in which elements are formed by applying lead salts mechanically to conducting supports.

The objects of this invention is to provide a simple, economical and efficient secondary battery and process for manufacturing the same. A further object of this invention is to increase the efficiency of conversion between charge and discharge, and most of all to decrease the weight of the cell without impairing its commercial value, and consists principally in the improvement of the structure of the metallic supports for holding the active material and in the successful adaptation of the metal aluminium as a substitute for lead in the negative plate. It consists, further, in the method of forming the spongy lead of the negative element. It consists, further, in the electrolyte employed in the cell. It consists, further, in the method of electrically connecting the elements of the battery together so as to secure a uniform and equal electrical and chemical action over all parts of each plate. It consists, further, in the arrangement of the insulating and bracing separators that are arranged between opposing plates; and it consists, finally, in the processes, features, combinations and details of construction hereinafter described and claimed. In the art to which this invention relates, it is well known that many different kinds of conducting supporting plates and grids have been designed to prevent the active material from falling out, and also to guard against buckling of the plates, but as is also well known, these plates have not secured these results in the most economical or commercial manner. In order to prevent the warping or buckling of the supporting plates, manufacturers and inventors have attempted to prevent the same by hardening them with alloys and by using an increased weight of lead, the increase of the lead being such that the metallic support presented the largest percentage of the plates, while the real active proportion thereof was relatively small.

It is well known that the attempts to use aluminium as a support for the lead paste or active material have failed for the reason that paste does not adhere readily to the aluminium, and as a consequence fell away therefrom, so that the attempt to use such material in storage batteries has been abandoned, and such material has never entered into commercial use in the art.

My invention is intended to obviate these objections and to provide simple, economical, and efficient secondary batteries of very light and large capacity.

In experimental use and tests I have discovered that the hitherto damaging results from the expansion of the lead salts of positive plates can be turned to good effect by using a thin or mechanically weak rolled lead conducting support, which is free to expand under pressure from the salts, but has its expansion directed principally in straight lines parallel with the face of the plate, that is, the plate may stretch equally in all directions so that there is no tendency to buckle. I also prevent the buckling and increase the rigidity of the plates by inserting vertically corrugated and perforated insulating separators between each pair of elements in the battery.

In constructing a secondary battery in accordance with these improvements, a positive plate is made of thin rolled sheet lead and the same is provided with a series of rectangular or elongated perforations. The supporting plate is provided with terminals at the top and bottom portion thereof so that plates of the same polarity may be electrically connected together at the top and bottom, and thus ensure uniform electrolytic action.

The ribs formed by and between the elongated perforations are bent alternately to opposite sides of the plate, so as to form longitudinal recesses substantially the entire length of the plate, and openings on each side thereof, to hold the active material which consists preferably of a specially prepared hard but porous paste of red lead. This arrangement permits of a very light plate, the presenting of a large active surface, and a greater amount of active material than any other form of construction.

In order to make the improved negative element I use a plate similar to the plate above described in connection with the positive element, with the exception that I use the metal aluminium for the supporting plate, instead of lead, and the same paste for active material by placing the material in the plate, it is locked therein from side to side and throughout its entire length as in a cage, and prevented from falling out, while at the same time the surface of the active material represents a larger percentage of the surface of the plate than ever accomplished before, thereby greatly increasing the surface of the active material and the output of the plate, the weight of the cell being also largely decreased per unit of work.

In practice the weight of my positive lead support, when compared to the active material upon it, is as 1 is to 2, a result never practically obtained before.

The elements are connected together by bending the terminals substantially at right angles to the plate and connecting the plates of similar polarity to each other by means of rivets for the negative plate, and also by autogeneous soldering in the positive plate. The sets of plates are then immersed in the special forming bath, consisting of an aqueous solution of about one-third saturation of sulphate of zinc with 15 per cent. by volume of sulphuric acid.

In this solution I place the plates to be formed, suitably arranged between sheet lead anodes as dummies, and pass a current of about 1 ampere for every 3 square inches of the plates to be formed. On passing the current to the plates, the sulphate of zinc is decomposed, depositing pure zinc upon the negative pole plates, which is resolved from the plate as fast as it is deposited by the sulphuric acid of the solution, thus producing a quantity of hydrogen. By the reducing action of the hydrogen the oxide of lead is rapidly converted into spongy lead. By this process the time of formation is reduced to about two hours, about one-fifteenth of the time required in the processes in actual use at present.

By this method of forming the elements, the dissolved zinc is returned to the solution so that the same solution can be used over and over again for an indefinite period. I have found in experimental tests that the positive plates when first formed into negatives of spongy lead by this process, and then into positives, will give almost their full output on the first discharge, while the old methods require several charges and discharges before the positive plates are fully formed. I therefore also quicken and cheapen the formation of positive plates by the use of quick negative formation.

After formation the elements are placed in the battery, and in order to strengthen and insulate the plates and prevent warping or buckling of the same, I insert between the opposing pairs of plates a corrugated insulated perforated separator which touches such plates at their inactive portions.

By this arrangement no active material is covered by contact with the insulated rubber separator and the internal resistance of the cell is thereby greatly reduced. A T-shaped terminal lug of lead is then secured to the terminal of the positive lead plates and a similarly shaped lug aluminium to the aluminium terminals of the negative plates to which the circuit wires are intended to be attached. It is well known in this art that each time a cell is recharged the negative element decreases in capacity, and that after a time a reversal of the polarity of the positive and negative elements is necessary to bring the cell back to its original capacity. This is avoided and the efficiency of the conversion increased between charges and discharges by adding to the usual sulphuric acid electrolyte (with which all batteries are supplied) a very small proportion of sulphate of zinc, just sufficient to hasten, as described in the former bath, the restoring of the negative element so that its full capacity is restored fully as quickly as that of the positive element.

In the construction of storage batteries all builders connect the elements together by a terminal at the top end, and at one point only. I have discovered in connecting the elements in this manner that in the charge or discharge of the battery, the escape of the current to and from the positive and negative plates is greatest nearer to the terminal lugs, and that it gradually decreases to the more remote points. This action brings about uneven electrolysis upon the plates, to the extent that one portion of the plate (that nearest the terminal) is exhausted or restored quicker than the more remote portions, in consequence of which the capacity of the battery is decreased below the capacity of the active material. It also produces partial polarisation and unequal expansion, and consequently distortion or warping of the plates. In my construction, I remove these objections and obtain a much more uniform electrolysis on every portion of the plate, by connecting the plates of similar polarity at two or more points below the line of the electrolyte. It will be understood, however, that instead of using two terminals, one only may be used, and that one extending nearly the entire length of the plate, or three terminals or even more may be used. In further carrying out the benefits derived from the above described points, the plates of opposite polarity are placed in juxtaposition with each other, so that the connected edges are on opposite sides of the pile. Further, in the use of batteries, the terminals of the plates, or the elements above or outside of the electrolyte are destroyed by the sulphating of the lead, due to the combined corrosive action of the air and acid, and to overcome this, heavy lugs are resorted to. I avoid this objection by completely immersing the terminals of the elements at the point where they connect, so that I can successfully use thin plates in my elements where hitherto destructive sulphating has made it impossible.

TEST OF THE CHICAGO STORAGE BATTERY ROAD.*

(*Concluded from page* 348.)

Data on Batteries Obtained at the Time of Power House Tests.

Two complete power house tests made on November 5th and November 26th, 1897, showed the amount of coal required to deliver a kilowatt-hour upon the switchboard. At the same time a complete log of the operation of the battery charging pit was kept, which shows the history of each battery for the entire time of the test. In the test made November 5th the batteries were charged by the "three-voltage" method, but on November 26th the station was operated with one generator, and but one voltage was used to charge the batteries. During the latter part of this test the tracks became covered with ice, due to a sleet storm, and it became necessary to change the batteries every half trip, which will account for the shorter time of charging indicated upon the latter part of the power station log of the test, and also the smaller average number of miles per trip shown November 26th. The data obtained at the charging tables were checked up with the conductors' reports. These reports show the number of the car, the time occupied by each trip, the length of the run, and the number of the battery used. The following table shows a summary of this information for the two days. This table shows the battery mileage for each day from the time of starting the road in the morning until the last trip at night.

Table of Battery Mileage.

No. of battery.	November 5th.		November 26th.	
	No. of trips.	Miles run.	No. of trips.	Miles run.
1	2	33·0	...	...
2	2	22·4	...	...
3	4	63·9	3	44·5
4	1	11·8	3	66·9
5	5	100·7	2	33·9
6	4	67·2	5	56·6
7	4	68·4	6	77·0
8	...	...	...	...
9	3	43·6	3	41·4
10	5	49·5	4	53·7
11	...	...	5	58·6
12	5	79·6	...	...
13	1	11·5	6	68·1
14	1	23·0	...	...
15	1	11·5	5	7?·8
16	...	...	...	...
17	...	...	...	...
18	...	...	...	...
19	1	11·5	4	62·2
20	...	...	5	56·9
21	5	80·2	2	34·2
22	5	79·0	4	55·4
23	1	10·6	.	...
24	...	...	...	...
25	3	47·1	3	57·2
26	5	79·6	2	22·4
27	1	10·6	4	57·2
28	1	11·8	3	50·6
29	4	79·0	4	56·3
30	4	73·9	4	31·2
31	2	45·4	...	...
32	6	68·1	...	...
33	4	79·3	4	56·2
34	4	78·4	2	34·2
35	...	...	6	89·9
36	...	...	5	78·7
37	3	67·8	3	35·1
38	4	81·6	3	46·0
39	...	...	...	...
40	5	77·8	5	67·8
41	4	80·1	6	90·2
42	4	68·1	3	30·6
43	2	22·6	4	43·4
44	4	80·2	3	34·2
	110	1,821·8	123	1,668·4
Average miles each trip		16·56	...	13·56

This table shows the actual number of miles which the batteries ran the cars on the two days. In addition to this, batteries were used to operate the auxiliary motors of the plant. These motors are upon the transfer carriage used to handle the batteries in the charging pits, and upon the transfer carriage used to move the cars in the car barns. No record was obtained of the power used by these motors. A recording wattmeter was secured to place in these auxiliary circuits, but unfortunately it was injured in transportation, and could not be used. An effort was made to obtain an average value of the power used for each operation by means of readings made at

* *Street Railway Review.*

intervals of two seconds upon standard volt and ampere meters, but owing to the sudden fluctuations the data obtained were unsatisfactory. However, as the power used in the operation of handling the batteries in the pits and the cars in the barns may properly be charged to the operation of the cars, the total amount of energy delivered to the charging tables divided by the actual car mileage will give the total power required per car mile. With the data at hand, however, this entire energy cannot be exactly divided into the amount used in the barns and the amount used on the road. The former amount will be a very small proportion of the latter, but this proportion will increase as the average length of battery trips decreases.

The power delivered to the switchboard and the amount of coal required upon November 5th is shown in the records of the test made that day. The power delivered upon November 26th was obtained for nine hours from the records of the test made from 3 p.m. to 12 m., and for the remainder of the day from the charts of the recording ammeter. The readings of this ammeter were carefully compared with the readings upon a standard ammeter, and found to be correct. These ampere readings were multiplied by the value of the average voltage found upon the test made that day, and the resulting watts added to those obtained during the test.

The following table shows a summary of the results of the two days' run:—

	Nov. 5th	Nov. 26th
Date of test		
State of weather	Rainy	Rainy and cold
Kilowatt-hours delivered to switchboard	2,638	2,895
Kilowatt-hours used by cooling tower motor	151	174
Net kilowatt-hours delivered to charging bus bars	2,487	2,721
Total number of car miles ...	1,821·8	1,688 4
Kilowatt-hours on switchboard per car mile	1·37	1·63
Pounds of coal per net kilowatt-hour	6·9	6·44
Pounds coal per car mile ...	9·45	10 50
Cost of coal per ton	$1.90	$1.90
Cost coal per net kilowatt-hour	·00655	00611
Cost coal per car mile	·00897	·00996

It will be noticed that although the cost of a kilowatt-hour upon the switchboard was less in the second test, the cost of fuel per car mile the same day was something more than in the test November 5th. This result is due to the fact that the kilowatt-hours required per car mile were greater in the second case. The difference in the amount of energy required per car mile is to be explained by the presence of a coating of ice upon the rails during the latter part of the day (November 26th). It is unfortunate that a freezing sleet-storm should have occurred at this time, though the results of the test indicate to a certain extent the amount of power required to operate the road under adverse conditions. Owing to the storm, the results of the two tests do not furnish a fair basis for a comparison of economy of the two different methods of charging the batteries.

Efficiency Test of Battery on Car.

This test was made November 8th, 1897, and was made to determine the efficiency of a battery under actual operating conditions. The battery was charged in the regular way by means of the three-voltage method. It was then discharged while making a round trip, and was then placed upon the charging table and again charged, thus giving two charges and one discharge to determine the efficiency. The battery used was one which had operated at that time over 8,000 miles, and was taken for the purpose of this test immediately after it had made a trip similar to the one upon which it was tested.

The current and voltage upon the two charges were obtained by means of standard instruments, and readings were taken every five minutes.

The observations made upon the car while the battery was discharging consisted in taking voltage and ampere readings every five seconds, while the car was in motion, the time between stops and the length and location of each stop, and a continuous record of the speed.

The voltmeter was a standard Weston instrument, and was connected across diagonal corners of the battery tray.

The voltmeter was so connected that it gave the voltage at the battery terminals for each combination. The car tested was 20 feet long in the body, 30 feet long over the platforms, and had a seating capacity of 28 passengers. The car weighed 13½ tons with the batteries, the batteries and trays adding about 4 tons to the usual weight of a car of that size.

The motor upon the car was a 50-H.P. Walker four-pole series motor. The entire current used at any one time passed through the armature, so that the ammeter was inserted in the positive brush leads. The ammeter used was of the round-pattern Weston type, and had been found to be correct by comparison with a standard. Five observers were used to obtain the ammeter and voltmeter readings. One called the time every five seconds, two read the instruments, and the other two kept the records. At time of starting the instruments were read oftener than at five-second intervals. A trial trip was made with another battery to get the observers acquainted with their positions, and as the fluctuations in the current were not violent nor many, it is believed that the results represent very nearly the actual facts.

The duration of the stops, and the time the car was in motion between stops, was obtained by means of a stop watch.

The record of speed was obtained by means of a Boyer speed recorder belted, by means of a flexible belt, to the car axle. By means of pressing lightly upon the recording pencil a dot was made in the speed curve every five seconds.

No attempt was made to indicate upon the diagram the ampere or voltmeter readings, as this information is given upon a larger scale in the acceleration tests.

The test may be divided in four parts, as follows:—

	Distance.	Time.	No. of stops.	Average speed miles per hour.
1. Power house to Blue Island ...	5 9	28:20	12	12·5
2. Blue Island to power house ...	5 9	29:55	19	11·8
3. Power house to Sixty-third Street	5·3	27:40	13	11·5
4. Sixty-third Street to power house	5·3	27:50	13	11 5
Total number of stops ...	...	...	57	

Total time from start, not including stops ...	113:45
Total distance	24·40 miles.
Length of one back-up stop, 18	·04 „
Total distance travelled	22·44 „
Average speed	11·84 miles per hour.

In making the stops, an effort was made to approximate actual service and in every way reproduce the conditions of an actual trip. No regular passengers were carried, however, the load consisting of nine observers, the motorman and conductor. The motorman was instructed to follow his usual custom of coasting, where possible. The track was dry for the first two parts of the test, but during the last two parts it was raining, and the tracks were wet. The energy taken from the battery was as follows:—

	Distance. Miles.	Watt-hours.	Kw.-hours per car mile.
1. Power house to Blue Island ...	5 9	5,533 1	·920
2. Blue Island to power house ...	5·94	5,098	·868
3. Power house to Sixty-third Street	5·3	4,394·6	·820
4. Sixty-third Street to power house	5·3	4,689 6	·885
Total	22 44	19,715·3	·878

It is to be regretted that a profile of the road cannot accompany this report. The road, however, is practically level. The results of the last table would seem to indicate that in general the grade rose from the power house toward the two terminals.

The efficiency of the battery is shown as follows:—

Kilowatt-hours, first charge	36·757
Kilowatt-hours, discharge	19·715
Kilowatt-hours, second charge	31·631
Efficiency (discharge ÷ first charge)	... 53·6 per cent.
Efficiency (discharge ÷ second discharge	... 62·32 per cent.

The graphical log of the two charges were shown, and they differed considerably. This is due to the fact that the charging of the battery was left to the regular operators of the plant, who used their judgment both as to the voltage and as to the time the battery should charge at each voltage. They also determined when the battery was fully charged. In the first charge there is no doubt but that the final voltage was too high, and in the second charge it would seem that the battery was charged too long, both of which conditions reduced the efficiency obtained. The result, however, shows the efficiency in actual service, but does not represent the possibilities of the battery.

The amount of the first charge was, of course, influenced by the immediate previous history of the battery, and for this reason the efficiency obtained by using the second charge as a basis is the more reliable. This test showed that the car used 1·41 kilowatt-hours per car mile, as measured at the charging table, and ·87 kilowatt-hour per car mile was delivered from the batteries to the motor on the car.

Acceleration Tests.

In the tests made upon a car in actual service no opportunity was afforded for actual acceleration tests. These were made November 13th, 1897, upon a straight stretch of track along Vincennes Road, extending south from the power house. In these tests the same instruments and observers as on the other car test were used, and readings were taken in much the same way, with the exception that in this test the observations were made at the time of passing from one point to another of the controller. After the fifth point was reached the readings were taken at 5-second intervals. The time between points was obtained by means of a stop watch, and no effort was made to change the motorman's method of procedure in bringing the car up to speed. The average results of five trials showed clearly the power delivered by the batteries at the different points of the controller and the energy required to accelerate the car.

The current curve showed a maximum of 320 amperes. At this time all four sets of batteries are in parallel, so that this total of 320 amperes indicates a total discharge rate of each

cell of but 80 amperes. At the fourth notch it coincides with the total current curve, and at this point indicates the highest discharge rate, which is seen to be 220 amperes, and this rapidly decreases until it reaches 100 amperes, which may be taken as a fair value of the current with the car in full motion. It is to be understood, of course, that the practice of coasting, in which the current is shut off, makes it impossible to obtain the power required per mile from this curve.

In conclusion, it may be said that the foregoing tests do not demonstrate the best results that may be expected of accumulator traction, and were not made for that purpose. No excuse is to be offered for the fact that the road was not operating under ideal conditions while being tested, as the primary object of the test was to determine where improvement could be made. If this is kept in mind when comparing the results with those obtained upon the trolley systems of about the same size, it will be seen that the cost of fuel for accumulator traction, of something less than 1 cent per car mile, is very favourable to storage battery traction. The improvements suggested by the test are now being made. The overhauling of the engines, the repair of the economiser flue, and the securing of a better coal than was used on the test, at a cheaper price, should bring the fuel cost per car mile well within ·5 cent. Figures upon the labour and maintenance factors in the cost per car mile would be of interest in this connection, but are not covered by the figures of the test. The labour account will no doubt be as small as that of any nine-car road, while figures upon maintenance would be premature at this time. The batteries have operated from 8,000 to 14,000 miles, and are standing the service remarkably well, so that the maintenance account, up to the present, has been comparatively small.

THE ECONOMY AND EFFICIENCY OF THE LARGE GAS ENGINE.

Writing to the *Engineering Magazine*, Mr. Dugald Clerk, the well-known gas engine expert, discusses the gas engine in its relation to large powers. We may take it that for small powers the gas engine has, for a long time, been a decided success. It is the only economical prime mover for small powers, and the smaller the power required the more striking has been its success and convenience. As soon, however, as powers are required such that to start the engine is difficult for a man by himself, the inconveniences of the gas engine appear. Until 1890 the gas engine was in a state of development. The Otto patent had given wealth to its owners, and this wealth was used to crush every other patentee who could be brought within striking range. After the expiration of the Otto patent in 1890, the superiority of the Otto cycle was made plain by the abandonment of other cycles of operation and competition in engines really commenced, and competition lead to the attempts at increasing sizes and powers. So far about 200 I.H.P. is the maximum size to which the Otto cycle has been successfully applied.

In 1879 *the* big engine was a 16 H.P.; it held the title for several years. In 1888 the hot tube igniter displaced the old revenue producing slide valve. In 1889 the Simplex engine of Delamere-Debouttville & Malandin was exhibited at Paris. Its power was 100 H.P., and it had an electric igniter and a self starter. Since that time the growth has been to 200 H.P. and not a large number of really big engines have been made, the average power of the 5,000 engines built annually in the United Kingdom being 20. The largest engines built by Messrs. Crossley for the Blackpool Tower Company are of two-cylinder type, each cylinder facing its fellow and using the one crank. With coal gas they show 220 H.P. The cylinders are 18½ inches diameter and the stroke is 2 feet, the speed being 160. With producer gas they indicate 208 H.P. This engine is really a pair of 100 H.P. cylinders on a 200 H.P. crank.

This arrangement, which gives two impulses in a revolution and leaves one revolution with no impulse, has proved better than the side by side cylinder, one crank type which gives one impulse every half revolution. Altogether, Messrs. Crossley have made about 30 engines of over 100 H.P. for various purposes, including the direct driving of dynamos and centrifugal pumps.

Messrs. Tangye have also turned out a considerable number of engines of over 100 H.P. and several other makers have made large engines, one by Messrs. Robey & Co. at Messrs. Luke & Spencers, of Broadheath, working on 1¾ lb. of coke per H.P. hour, including the coke used at night to keep the producer in form, but our author does not consider the total of large engines can exceed 100. As a large engine of 80 H.P. will run for about 1 lb. of anthracite per hour, or of common engine slack, how is it there are not more big engines with such an economy in view for the best steam engines of 80 H.P. would use quite double the above fuel? There are two sets of difficulties, those of the engine and those of the producer; of the first there is the proportion of burned gases left in the compression space—a fault which does not much trouble small engines, whose cooling rate is greater, and the burned-out gases are cooled below the point where they ignite the incoming charge. Some lingering flame remains to ignite the incoming charge in large engines, this ignites the charge in the inlet pipe and the engine loses an explosion. Hence the use of the scavenging charge which Mr. Clerk himself used first. This was in 1881 The Otto engine only adopted scavenging in 1886, and the Griffin engine is well known as having a scavenging stroke, but scavenging was not frequently done until Messrs. Crossley adapted Mr. Atkinson's inertia method. This consists of a long exhaust pipe, the momentum of the discharged gases in which was made to pull a charge of fresh air through the cylinder. Messrs. Wells Bros. had a special annular scavenging cylinder worked as an air pump by the expanded forward part of one piston in their 200 I.H.P. engines of tandem type. Scavenging is admitted to almost completely overcome the difficulty of premature ignition from residual flame, but an engine must be well designed so as to avoid hollow spaces and ports which might not be swept out by the scavenging air. Nor is it to be wondered that there should be premature ignition. With a temperature of 1,800° C. in a compression cylinder and a stroke lasting only one-sixth of a second there is little time for complete combustion. With small engines at even 400 revolutions per minute the ignition is complete, and premature ignition is even difficult to obtain, but large engines are different, having so large a cylinder volume for their capacity or rate of cooling. In many gas engines the initial pressure of compression is nearly 100 lbs. before ignition. In most large engines the terminal temperature exceeds 1,200° C. High compression has reduced this, and enabled more heat to be converted to work, and with scavenging nearly got rid of untimely firing on the charging stroke. But there is still the premature explosion during compression, which is due to the temperature of the high compression, and the piston end of an even well designed piston can hardly be less than a dull red, or, say, 700° C., while the gas must be probably 250° C. when compressed to 100 lbs., so that early ignitions are not to be wondered at. Carbon on the piston and projecting bolt heads are all in favour of causing ignition during compression, and should be avoided. Rich gas mixtures must also be avoided. There is also the risk of a cylinder becoming filled by a mixture of rich gas after several missed explosions. This may be caused by wrong adjustment of the gas and air admissions, and an explosive pressure 30 per cent. in excess of normal may occur. This never takes place with steam engines, and it demands special strength in crank pins, &c., and generally ample margins. Gas engines, therefore, are unduly heavy per H.P. developed, both because of this and because they are only half single-acting. Thus, in spite of all its thermo-dynamic advantages, it has not ousted steam power to the extent which might have been expected. Our author also does not think gas producers are by any means perfect. The Dowson producer requires anthracite at 18s. per ton, so that with a Dowson producer the half weight of fuel used cost more than the double weight of cheaper fuel for the steam engine.

Dowson producers now use coke, but the difficulties with coke are not yet overcome. The Mond producer, according to Mr. Clerk, is the only one making gas fit for use in the gas engine, and this producer is cumbrous and only excellent where ammonia recovery is also carried out. Our author has evidently not seen the Thwaite duplex producer at the works of Mr. Arthur Porritt of Cleckheaton, where, we believe, the cheapest slack is being used and every satisfaction is being given. So far as we can learn, this duplex producer is doing exactly what Mr. Clerk says is required to cause the rapid development of gas power.

A 10 H.P. Crossley engine with 95 lbs. initial compression is showing 22·2 B.H.P., with a consumption of 14·32 cubic feet of Manchester gas per B.H.P. Apply the same economy to large engines and no doubt a B.H.P. hour would be got from 12 cubic feet or 30 per cent. of the heat given to the engine will be returned as work.

In 10 years' time engines of 1,000 H.P. will be as common as those of 100 H.P. are to-day. Before applying gas engines to large marine work they must be improved in construction, governing and operation. When the time arrives for this use of gas the equivalent fuel will be easily as low as half a pound per I.H.P. hour.

A good deal of labour has been spent on self-starters. We do not look on self-starters as having a use except between the small engines and those of the maximum size yet made, but are inclined to the view that large gas engines will be started by the intermediation of small engines as with the little so-called barring engines of the textile districts. Undoubtedly there is a future for gas power at sea because of their economy, on land because of the millions of feet of good producer gas sent to waste from every blast furnace.

THE TELEGRAPH TROUBLES.

The Clerks' Point of View.

By CHAS. H. GARLAND.

(*Continued from page* 276.)

There may seem to be a lack of logical arrangement about the order in which the points have been discussed in these papers. This arises to a great extent from the necessities of the case. Such a multiplicity of reasons exists to be discussed that the arrangement has to depend largely on the nature of the evidence rather than on the point contended for. But, undoubtedly, any point which involves a positive wrong, a breach of the promised conditions of service, assumes a greater importance than any claim for an improvement of such conditions. This will explain why the restitution of a scale already conceded was discussed, before dealing with necessary improvements in that scale.

One of the most important improvements asked for has been a better salary after five years' service. "After

five years' service" is equivalent to saying at 21 years of age. The average age of entrants into the telegraph service is 16 years; hence, five years later, they enter upon manhood. If it were not for the many objections to an age-scale in the Civil Service, the claim would in all probability have been made for men of 21 years of age instead of "after five years' service." However, the number of entrants under 16 years of age is almost a negligible quantity. The claim, then, is practically a claim for a salary upon which a young man can live, which should be given him at the time he passes from adolescence to manhood. The reasonableness of his claim has been admitted by heads of departments. Thus Mr. H. C. Fischer, C.M.G., Controller of the Central Telegraph Office, in giving evidence before Lord Tweedmouth's Committee on this point, on November 8th, 1895, said: "With regard to the five years' service men, I am of opinion that they are underpaid at that period. The commercial value of the service they perform at that time is much higher than the wages they receive." "I have always held that telegraphists are not getting sufficient at that time. They scarcely get sufficient to keep themselves, and yet are, as a rule, rendering very efficient service." Asked how much the salary should be increased, Mr. Fischer suggested £10 or £12 per year, adding that less would be insufficient. This is a most pathetic picture. The head of a large State monopoly confessing that despite, or perhaps because of, the postal profit of three to four millions per year, a number of its young servants do not receive enough salary to keep themselves.

It is proverbially difficult to reach the heart and conscience of a corporate body, but surely we have here a thing that should touch the individual hearts of even so impersonal a corporation as "the Department," or, if need be, that mysterious and callous entity, the Treasury.

Mr. Fischer was not alone in his view. Support was given by other officials, and from the most unlikely quarters. Mr. J. C. Badcock, Controller of the London Postal Service, on November 11th, 1895, when giving evidence before the same committee, said: "I think the pay in the lower stages is somewhat inadequate." "There should be a material increase after five years' service." Mr. W. H. Preece, F.R.S., said: "I have no doubt that a clerk of five years' service under the present scale does not acquire sufficient to keep himself in a proper position." Even Mr. Lewin Hill, with all his dislike to generous scales for the minor establishment, provided for an increase after five years' service in the proposed revision he submitted to Lord Tweedmouth. When the reasons for an increase at a certain point are so strong as to convince the heads of departments that a readjustment is necessary, it is a fair assumption that overwhelming evidence must exist in its favour. Yet nothing, or practically nothing, has been done. Under Mr. Raikes's revision a clerk got £63 after five years' service; under the present system he receives £64. So, in the face of all the evidence of the necessity for a "material increase," which Mr. Fischer thought should be £10 or £12 a year, he receives the munificent sum of £1, or 4½d. weekly! Really, one is inclined almost to agree with the view expressed by Mr. H. M. Hyndman, in the January *Cosmopolis*: "The Post Office . . . . employs men and women in vast numbers, with as little regard for their general well-being as if the State were itself a greedy private employer or an unscrupulous limited company."

But it were unfair not to state here that in order to encourage a knowledge of both postal and sorting duties and the acquirement of technical knowledge, an extra increment of £6 is offered to all those clerks who pass an examination in sorting duties, and a further £6 for passing an examination in technical telegraphy, telephony, and in magnetism and electricity, such double increments not to affect the maximum of the scale. This latter condition means that technical knowledge is of no value in a man at his maximum, although it be valued at £6 annually in a man lower down the scale. For telegraphists at the Central Telegraph Office the sorting increment is a dead letter. Of 18 men who have attempted to obtain it—a sufficiently small proportion of 2,000—all have discarded the attempt because of the difficulties attendant upon it. The other increment for technical work is being taken up.

That such encouragement—small as it is—should be given for the acquirement of technical knowledge is a matter for rejoicing, but that it should be regarded as in any way meeting the difficulty of inadequate pay, is food for many reflections. The pay after five years is inadequate, it does not pay the men the commercial value of their services; but before giving any relief the Department exacts further services—further qualifications. The pay is at least £10 or £12 per year less than the value of the work already performed, and yet you must give us more and better work before we increase it by £6. So, in effect, says the Department. A body of young men who are admittedly receiving "scarcely sufficient to keep themselves," are taxed in class fees, cost of books and time, before they receive a very inadequate measure of relief. Telegraph clerks are as little inclined as others to look a gift-horse in the mouth, but when, after praying for years for necessary bread they are offered a stone, can it be wondered at that they grumble? So the underpaid five years' man it still discontented.

There are many other points in connection with the salaries of telegraph clerks which are anomalous and unjust, but a volume could be filled with an exhaustive exposition of them. These papers will only deal with some of the main points, and constitute a summary. But they will be a summary which will throw a light on methods and principles which should have no place in a State Department. The scales asked for by the Postal Telegraph Clerks' Association, as a means of settling the whole matter, are moderate, and meet all the difficulties. Before passing to the question of annual leave, which is a vital question with the men, a quotation from a letter by the genial, but just Mr. A. Birrell, Q.C., M.P., will, I hope, justify itself. "What is the duty of a State Department to its servants?" he asks: "That telegraph servants are cruelly underpaid is certain; on the other hand, such is the state of trade, and so overcrowded are the markets, that there would be no difficulties in filling the places of any of the servants of the Department who chose to vacate them. The taxpayer is the ultimate employer in this case. Is it fair to him to make him pay fancy wages? This much is clear—that a public establishment which brings in a revenue, ought to treat its workmen as generously as the highest class of private employer; a wealthy man who sweats a poor man is admittedly a rascal. If the State cannot afford to run the telegraphic system, except by underpaying its servants, let it give the business up. All public departments are sickening institutions, and nobody can contemplate the State becoming the universal employer without dismay, except by assuming that in future public departments will be totally unlike what they are and always have been."

The question of annual leave is one which causes much bitterness of feeling among the staff. What is the object of annual leave? To be a rest from the work and worry of the office, from the stress and turmoil of the City. The majority of the readers of the Electrical Review look forward to their annual holiday, I am certain, as a period of happiness and sunshine, of rest and quiet. In one's mind the prospect of annual leave is always pictured on a background of hill and dale, green meadows, or foam-flecked sea. The days are long spells of light, of sunshine, and the nights are canopied with a vault of spangled, deep-hued blue. So should a holiday be. But what is the background of the underpaid telegraph clerk's holiday? Mist, fog, rain, sleet, and all the wintry grime of a city's streets. No sunshine at home, nothing but a leaden sky, and no money with which to fly to the South of France in search of warmth and light. Year after year the young men of the telegraph service take their holidays in winter, and year after year they will continue to do so unless some radical change be effected. The periods are chosen by seniority, and are spread equally over the whole year. So one-twelfth of the staff goes in November, one-twelfth in December, one-twelfth in January, and one-twelfth in February. And the same unfortunates continue to be relegated to these months year after year.

Sir Albert K. Rollit said at the Treasury Conference last year: "No matter what class a person may be in, the public are dependent upon skilled labour, and the staff should not be compelled to take its holiday during the winter, whatever the alternative may cost, so long as there is a balance of revenue." He further declared, when the female representative was under examination, "I think it is revolting to hear a young person such as that say she is never to have a summer holiday. It cannot be to the interest of the individual

or the State." Mr. Hudson Kearley, M.P., himself a large employer of labour, on the same occasion, said: "There is no other service in the country—public or private—where holidays have always to be taken in the winter. No railway company and no private employer imposes such a condition." Lord Tweedmouth's Committee in their report, said: "We think that the request that the annual leave should be granted in the better months of the year is natural, and are agreed that whenever the conditions of service will permit, every endeavour should be made to meet it." The Duke of Norfolk and Mr. Hanbury promised, after the Conference at the House of Commons, that an attempt should be made to devise means of improvement. And on this promise the telegraph service relied, with the result that the holidays at the Central Telegraph Office are based upon the same principle this year as last. What is the real difficulty in the way of granting this natural request. The Controller or the Central Telegraph Office should know, at least so far as his own office is concerned. The following abstract from his evidence before the Tweedmouth Committee is therefore conclusive.

4,064. The CHAIRMAN: Is it not practicable to confine the holiday period to the eight months of the year?—It is a question of expense.

Later on, following leading questions from his chief, Sir S. Walpole, he added other reasons; but to anyone who understands the ordinary human being, no comment is needed. Undoubtedly the question of expense is the stumbling block in the way of deleting the four months, January, February, November and December from the holiday sheets. Yet the Duke of Norfolk and the secretary to the Treasury have pledged their personal words to devise some improvement. Are telegraph clerks unreasonable in asking that some of the annual profit of four millions should be spent by the Postmaster-General in redeeming his word of honour? In Germany, where the conditions of pressure are the same as in England, the additional expense is incurred, and the summer months are the holiday months. And even in other branches of the English postal service the holidays are confined to the eight best months. Up to now, no hint has reached us, that the Postmaster-General and his immediate staff ever take their annual leave in winter, whatever the conditions of work or expense.

(To be concluded.)

STORAGE BATTERY TESTING AT HIGH DISCHARGE RATES.

By RANKIN KENNEDY.

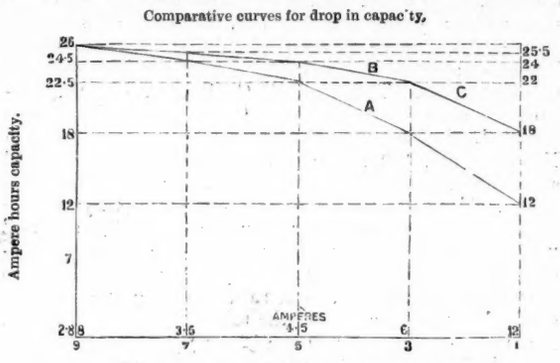
It is well known that in all storage cells in which solid active materials are used the capacity falls rapidly as the rate of discharge is increased. Without entering into the cause of this peculiar phenomena we can endeavour to ascertain the amount of drop in various cells as we increase the discharge rate.

Some of the drop is due to internal resistance of the electrolyte, this can be measured by the difference in terminal pressure with and without the current flowing, but the greatest fraction of the drop is due to something more than internal resistance, and this something varies in value in different cells.

For traction purposes cells are tested for watt-hours per lb. gross weight, spread over a time of from 5 to 8 hours' discharge, but for lighting purposes the gross weight of the cell is of minor importance, while the drop in capacity as the discharge rate increases is of very great importance. Cells at central stations may be called upon to deliver their full discharge in 1 or 2 hours, hence the cells which give the greatest capacity at highest rates are best for that purpose.

If we take two cells of different makes, we will find that if the cells are made for the same discharge rate and capacity on a fairly long discharge, or that at low rates they are practically equal, say, that at 2·88 amperes the capacity for both comes out 26 ampere-hours on a 9-hours' run; if we now discharge them at 3·5 amperes we find cell A finishes in 7 hours with a capacity of 24·5. Cell C in same time has not run down but gives 25·5 capacity, and so on we can obtain readings which, when plotted out as in diagram, give curves, showing that although the cells are equal in capacity at the low 9 hours' discharge, that they are not equal at the higher rates, C being by far the better cell.

The curve, A, is one found by actual tests. The figure 1 on horizontal is cut by an ordinate passing through 12 and 18, showing that cell A discharged in one hour, gave a



capacity of 12, while C, discharged at same rate, gave 18, that is, at 12 amperes A discharged in one hour while C ran on for 1·5 hours. A is here taken as a standard for comparison.

On the 3 hours' discharge at 6 amperes, cell A gives 18 ampere-hours, cell C gives 22, and so on, the difference diminishing as the rate diminishes.

That cells can be improved in this direction is clear by one example. Thus the E.P.S. central station cell, K-type, is made for 310 amperes rate discharge in 7 hours; at this rate it gives a capacity of 2,170 ampere-hours, but discharged in 1 hour it gives only 1,050 ampere-hours' capacity, while their improved F.K. cell for same capacity at the low 7 hours' rate of discharge, now gives 1,230 ampere-hours' capacity in a 1 hour discharge—a very well marked improvement. In this comparison we take two cells equal at the 7 hours' discharge, and find that they are to each other on a 1 hour discharge as 10·5 is to 12 3.

For all practical purposes cells for rapid discharges may be compared in this way by making two tests only; one at a 6 or 7 hours' run, or any other time at which the cells to be compared are equal or nearly equal in capacity, then make another test at a rate to discharge the cells in one hour, the difference in capacity between the two cells at the higher rate indicates the difference in efficiency between the two cells. Thus, to take the above example:—

$$\text{This efficiency is equal to the } \frac{\text{ampere-hours at high rate}}{\text{ampere-hours at low rate}}$$

With a perfect cell it would be unity.

In the above example the discharge of K cell at low rate is 2,170, and at high rate 1,050, therefore efficiency is

$$\frac{1,050}{2,170} = 0{\cdot}484, \text{ the F.K. cell } \frac{1,230}{2,170} = 0{\cdot}567.$$

The figures are not the gross efficiency given by watt-hours put into cell and watt-hours given out by cell, but are comparative values indicating the drop in output as the rate of working increases.

It would be instructive and interesting if the data were available to compare these curves for a cell of the strip type like Blot's, with a cell of grid type. Theoretically the curve should be better in cells where the active material is spread thinly over large surface.

Whether this is borne out in practice cannot be proved by the author owing to the absence of data.

In this way the all-round performance of any cells can be indicated, even for traction cells it is the best test between two cells of nearly same watt-hours per lb. at the long discharge.

Some such test is necessary, for traction cells have to work at all rates of discharge, so that to arrive at an approximate idea or value of the cells under working conditions the two tests are required to fairly compare two cells.

Of course, this is a supplementary test in the case of traction cells, and whatever the cells may be which are to be compared they must give same capacity in the 6, 7, 8, or 9 hours chosen as the low rate time. Two cells may give same capacity at low rates, and if their watt-hours' capacity per lb. is equal, or nearly so, at that rate, it is clear the watt-hours' per lb. of the cell which has highest capacity at the high rates will have the highest value in actual work on a variable load.

Only in the impossible case of a cell with no drop in capacity on an increasing load is the test of capacity, at one or two low rates, any reliable index of the capacity under the varying rates found in practice.

It has hitherto been too readily assumed that if a cell is superior to another at one or two rates of discharge it is therefore superior all along the line.

In concluding these occasional articles on battery testing, it may be pointed out that while actual testing and noting down results is a simple matter quite within the capacity of a student at school, the laying out of the plan of the tests and the making of comparisons between the results observed and other results already published, is a task which presents some difficulties to those who are considered capable experts.

We have well known accepted methods for comparing engines, dynamos, motors, transformers, lamps and other appliances, but it seems we have no recognised methods for testing and reporting upon storage batteries in such a way that the results are comparable and above suspicion of errors.

REVIEWS.

The Law and Practice of Letters Patents for Inventions. By Lewis Edmunds, D.Sc., Q.C. Second Edition by T. M. Stevens, D.C.L. London: Stevens & Sons, Limited, 119 and 120, Chancery Lane. Price 32s.

The annual number of patents granted to inventors appears to be one of the best indications of the manufacturing activity of a country. At least, the United States, Great Britain, and Germany stand at the head of the list in both these respects. Probably the greatest number of inventions per annum are patented in this country, but though there may be some doubt whether we or the U.S.A. stand first in numbers, there can be no doubt that the patent law of this country is the oldest in the world.

We learn from the interesting history of Patent Law in Dr. Edmunds's volume that the grant of Letters Patent conferring a monopoly is one of the last survivals of the once extensive prerogative of the Crown. As late as the reigns of Edward III. and Richard II. the king claimed to give special privileges to individual traders, but the first patent for an invention in the modern sense appears to have been granted in the reign of Henry VI. to two aldermen "that they and their assignees should have the sole making of the philosopher's stone." Up to the time of Elizabeth patents were granted for new inventions, and also for restraint of trade in articles or arts already known. The latter class of monopolies were after a long struggle during the reigns of Elizabeth and James I. declared to be illegal, and the prerogative of the Crown was restricted to granting patents for new inventions only.

In 1624 the Statute of Monopolies was enacted, and it is on Section 6 of this Act that Letters Patent for invention depend. The present term of 14 years was then fixed, and the patent was to be granted to the true and first inventor only. The procedure for taking out Letters patent was subsequently modified by Acts passed in 1852 and 1883 and amending Acts in 1885, 1886, and 1888. Some idea of the long and cumbrous procedure necessary to obtain a patent before 1852 may be obtained, when we learn that the applicant had to make application at least 10 separate and distinct times to almost as many different officials. The Home Secretary, the law officers, the Lord Chancellor, all had a finger in the pie, and the wonder is invention was not strangled with red tape. Happily our Patent Law has now been simplified, and the cost of obtaining a patent reduced to a very moderate amount. Our patent system is still behind those of its leading modern rivals in one respect; it takes no steps to ascertain that patents are granted for new inventions only. The United States has examined inventions for novelty for the last 60 years, and the leading European countries, with the exception of France and Great Britain, have also adopted the American system.

Our patent practice has been otherwise brought, by a long series of legal decisions, to a state of great perfection, and in no treatise will a better exposition of Patent Law and Practice be found than in Dr. Edmunds's volume. The present edition extends to almost 1,000 pages, and appears to contain sufficient information to start a patent barrister or a patent agent in business in a small way. The subject matter of the volume is well arranged and indexed. It is divided into two parts; Part I. discussing Patent Law and Practice, and Part II. containing the Patent Acts at present in force, with full and valuable notes. Wherever we have tested the matter in this huge volume, we have found it reliable, accurate, and up to date; the style and arrangement is so clear, that a consulting engineer, or even a patentee without legal training might, in many cases, settle points in dispute about patent rights, and save the parties concerned from expending thousands of pounds on patent litigation.

Glass Blowing and Working. By T. Bolas, F.C.S., F.T.C. London: Dawbarn & Ward, Limited, 6, Farringdon Avenue, E.C.

The author, at the commencement of his book, points out that glass blowing is an interesting recreation as well as an industry, although very few people seem to recognise this. As cultivating delicacy of touch and perception, Mr. Bolas says it stands almost alone, though this is probably an exaggeration which an enthusiast always credits to the art in which he is particularly interested. A few pages which are devoted to the historical aspect of glass are decidedly interesting. Careful details are first given as to the best standard form of blowpipe; also various forms of bellows are described, and it is even shown how two pairs of ordinary domestic bellows may be adapted for blowpipes. The various tools required are next described in detail; in fact, attention to detail is a characteristic of the book. The working of glass for all kinds of philosophical instruments is fully gone into, so that the whole work makes an excellent treatise which can be highly recommended.

Journal of the Institution of Electrical Engineers, No. 131. London: E. & F. N. Spon, 125, Strand.

The general contents of this number are as follows:—"Accumulator Traction on Rails and Ordinary Roads," by L. Epstein.

The Workmen's Compensation Act, 1897. By W. A. Willis, LL.B. Third edition. London: Butterworth & Shaw and Sons, 1898.

This third edition of a really important little book has been revised and somewhat extended. We doubt if employers generally have given to the Act of 1897 that consideration which it deserves. They will find in the very near future that they have made a mistake by not so doing. The Act was that of a Conservative government, and probably had such an Act been brought into being by a Liberal or a Radical government there would have been such a terrific outcry through the length and breadth of the land, that all England would have been roused to a full and proper sense of the ruin of the constitution and the dangers of socialism, and all that sort of thing which is allowed to pass for statesmanship when hall-marked by the Tories. The new appendix consists of a form of application for certificate to scheme issued by Chief Registrar where employers and employed alike agree to a contracting out scheme. The Act itself is remarkable as the first instance in the history of English Jurisprudence, wherein a liability has been cast upon an individual to pay damages for injuries which are not the result of any negligence or other unlawful act either of himself or his servants, for whose conduct he is legally responsible.

An employer by this new Act is practically made to compulsorily insure his workmen, or failing to do so, he is liable for all or any of their injuries, to the extent of bankruptcy. Under common law an employers' liability has three limits,

known as the doctrine of common employment, accepted risks, and contributory negligence. The Act of 1880 was intended to destroy the first limitation. This Act left the door open for much evasion of its provisions and for much litigation. Mr. Asquith's Bill of 1893 was introduced to meet these objections, but was withdrawn because of the insistence upon contracting out by the Lords. By the Act of 1897 one limitation alone seems to be preserved, where a man's serious and wilful misconduct shuts him out of any compensation. What a field is here for litigation!! Serious and wilful misconduct!!! Who is to be the judge? Contracting out is limited to where a scheme has been formulated and certified by the Registrar of Friendly Societies as conferring benefits equal to the Statute. An employer cannot evade liability by sub-contracting. Perhaps this may help to wipe out the ridiculous objection to sub-contracting by London vestries and other bodies.

Speaking generally, however, the employers' lot is not a happy one. If he cannot be got at under the new Act the Act of 1880 may be brought to bear on him, and failing that the common law is still a weapon in the hands of his enemy. Then there is a Fatal Accidents' Act of 1846. The employers only chance, if he be a small employer, is to insure against all liability; if he be a large employer he may join his workmen in a scheme of contracting out. We would advise all employers to buy and read this book, and study its very stringent clauses. We are not quite sure if an employer would not be liable if one of his late workmen out on strike got hurt while on picketting duty.

General Elementary Science. Edited by WILLIAM BRIGGS, M.A., F.C.S., F.R.A.S. London: W. B. Clive, University Correspondence College Press.

We have received from the University Correspondence Press a copy of another edition to the long list of books that have appeared in recent years for the use of science students. This work, written by four authors of considerable reputation, under the editorship of Mr. William Briggs, covers the general ground of elementary mechanics, physics, and chemistry, and is particularly designed for the Matriculation Examination of the University of London. It is arranged in a series of more or less disconnected paragraphs, as, indeed, many successful educational books have been, from Euclid and Routh's Rigid Dynamics, downwards. Regarded as a cram book, *i.e.*, a book arranged with the definite purpose of preparing candidates for examination, we do not see how it could well be improved. The arrangement of the propositions is logical and consecutive, the explanations are simple and exact; where a complete definition may be beyond the students' comprehension, *e.g.*, in that of electrical potential, a note is added; the illustrations seem sufficient for the purpose. Every page contains evidence of the intellect required for the production of a good elementary book. The volume is of a convenient size for the pocket, and the typography is excellent.

NEW PATENTS.—1898.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W C., to whom all inquiries should be addressed.*]

4,879. "An improved method of distribution of news and music by telephone." L. E. WILSON. Dated February 28th.

4,895. "Improved manufacture of insulating conduits for electrical conductors and appliances employed in connection therewith, and for laying the conductors therein." F. T. WOODCOCK. Dated February 28th.

4,900. "Improvements relating to joints of telegraph wires." A. A. COMMON. Dated February 28th.

4,903. "Improvements in primary batteries." J. E. FULLER. Dated February 28th. (*Complete.*)

4,910. "Improvements in, and relating to, primary batteries." C. KOENIG. Dated February 28th. (*Complete.*)

4,926. "Improvements in, and relating to, portable electric lamps and batteries therefor, and for other purposes." H. H. LAKE. (L. Paget, United States.) Dated February 28th.

4,929. "Improvements in, or relating to, electric railway conduits and conductors." A. J. BOULT. (R. Snyers, Belgium.) Dated February 28th. (*Complete.*)

4,995. "Improvements in electro-magnets or magnetic closers for use on electric railway vehicles." J. N. THOMAS. Dated March 1st. (*Complete.*)

4,999. "Improvements in, and relating to, electric railways.' W. M. BROWN. Dated March 1st. (*Complete.*)

5,001. "Improved controlling system for electric railway vehicles." S. H. SHORT. Dated March 1st. (*Complete.*)

5,029. "Improvements in regulating apparatus for arc lamps." H. LEITNER. Dated March 1st.

5,034. "Improvements in, or relating to, electrolytic electrical meters." C. O. BASTIAN. Dated March 1st.

5,048. "Improvements in electric meters." EVERSHED & VIGNOLES, LIMITED, and S. EVERSHED. Dated March 1st.

5,049. "Improvements in alternating current motors." W. STANLEY. Dated March 1st. (*Complete.*)

5,054. "Improvements in current collectors for dynamo-electric machines." G. W. NELL. Dated March 1st. (*Complete.*)

5,062. "Improvements in incandescent electric lamps." W. P. THOMPSON. (J. T. Lister and W. S. Chamberlain, United States.) Dated March 1st. (*Complete.*)

5,064. "Improvements in non-synchronous electric motors." R. BELFIELD. (B. G. Lamme, United States.) Dated March 1st.

5,065. "Improvements in arc lamps." R. BELFIELD. (H. P. Davis and F. Conrad, United States.) Dated March 1st.

5,066. "Improvements in electric switches." R. BELFIELD. (H. P. Davis and E. F. Harder, United States.) Dated March 1st.

5,067. "An improved means for feeding the carbons in electric arc lamps." C. WOOD. Dated March 1st.

5,068. "Improvements in and relating to the carbon-feeding mechanism of electric arc lamps." C. WOOD. Dated March 1st.

5,083. "An improved means of and apparatus for varying the strength of electrical currents." R. HOPE-JONES. Dated March 2nd.

5,130. "Method of utilising the interior of electric incandescent lamps for advertising purposes." L. BISHOP. Dated March 2nd.

5,133. "Improvements in electric lamp fittings." J. M. HUISMAN and H. C. GOVER. Dated March 2nd.

5,162. "Improvements in the manufacture of waterproofing coating compositions for wearing apparel, covers, engine and other packings, acid tank linings, electrical insulating compositions, and for other uses." C. J. GRIST. Dated March 2nd.

5,172. "Improvements in telephone transmitters." J. V. COLLINGWOOD. Dated March 2nd.

5,176. "Improvements in means or apparatus for starting and regulating electric motors." J. H. HOLMES. Dated March 2nd.

5,177. "Improvements in dynamo-electric machines." W. B. SAYERS and MAYOR & COULSON, LIMITED. Dated March 2nd.

5,178. "Improvements in the manufacture of electrical transformers, and other alternating current apparatus having iron cores." A. F. BERRY. Dated March 2nd.

5,185. "Improvements in electrical conducting apparatus for tramways, railways and the like." C. F. P. STENDEBACH. Dated March 2nd. (*Complete.*)

5,186. "Improvements in or relating to secondary batteries." R. HADDAN. (H. Dolter, France.) Dated March 2nd. (*Complete.*)

5,208. "Improvements in electrically operated gas valves for burners." THE ACTIENGESELLSCHAFT FUR FABRIKATION VON BRONCEWAAREN UND ZINKGUSS VORM., J. C. SPINN & SOHN and S. J. VON ROMOCKI. Dated March 3rd.

5,260. "An improved primary battery." E. A. MITCHELL. Dated March 3rd.

5,287. "Improved coin feed mechanism for making and breaking electrical contacts." R. HADDAN. (M. Vidal, France.) Dated March 3rd.

5,288. "Improvements in globes or bulbs for electric incandescent lamps for decorative advertising and other purposes." P. HERRE. Dated March 3rd.

5,300. "Improved means for lighting railway trains electrically." R. R. MEACOCK and A. J. HARPER. Dated March 4th.

5,343. "Improvements in fluids for impregnating bodies or suitable fabrics, threads, fibres, or the like, for incandescent lighting purposes." F. P. FOSTER and G. (BODO) PUCHMULLER. Dated March 4th.

5,379. "Improvements in the manufacture of deep sea telegraph and telephone cables." W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED, and G. SUTTON. Dated March 4th.

5,418. "Improvements in electric telephony." C. ADAMS-RANDALL. Dated March 5th.

5,423. "An automatic electric switch for hoists and cranes." J. GODDARD. Dated March 5th.

5,449. "Improvements in 'oscillographs' or apparatus for indicating or recording rapidly varying electric currents or potential differences." W. DU BOIS DUDDELL. Dated March 5th. (*Complete.*)

5,469. "Improved system of electric traction and apparatus therefor." A. J. BOULT. (J. P. Anney, France.) Dated March 5th. (*Complete.*)

5,478. "Improvements in alternating electric current transformers." J. A. MCMULLEN. Dated March 5th.